INSTRUCTION MANUAL

Volume 1

SD360 DIGITAL SIGNAL PROCESSOR

(MODIFIED TO MODEL SD360-75)

GENERAL INFORMATION

Preliminary Copy

SPECTRAL DYNAMICS CORPORATION

INSTRUCTION MANUAL

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GENERAL INFORMATION

Preliminary Copy

August 1975

ADDENDUM

Model SD360-75 Digital Signal Processor

(Comprising Unit 1 and Unit 2-12-70)

The Model SD360-75 is a modified version of the standard Model SD360 Digital Signal Processor. The standard SD360 Instruction Manual, together with this addendum provides the documentation for the Model SD360-75.

The "-75" designation added to the basic model number indicates modifications to Unit 2, which are listed here and supplied with this manual.

1. Model SD360 Unit 2-12 Data Transfer Controller

2. Model SD360 Unit 2-70 Retrace Inhibit

11/17/75

Rev. 2/4/76
Rev. 3/26/76
Rev. 3/29/76

ADDENDUM

Model SD360 Unit 2-12 Digital Signal Processor

The Model SD360 Unit 2-12 is a standard Model SD360 Unit 2 that has been modified to operate with a Model SD25-182 Data Transfer Controller.

Modification of Card A3, Input Address (Figure 1): The OR'd circuitry disables input memory hold interlock, allowing Memories A and B to be held independently.

Modification of Card A20, Cursor and Control (Figure 2):

a. An AND gate is placed in-line to Pin 2 of U33, and the sample pulse output (B-connector Pin 39).

b. A new sample clock inhibit (from the SD25-182) is input to the new gate via B-connector Pin 46.

c. The connection from 12 of U34 to U24/U32 is removed and a new connection made between U34 and Pin 13 of U33.

d. The input to U24/U32 is connected to Pin 2 of U33.

Modification of Card A21, Offset Generator (Figure 3): Two NAND gates are in series with Pin 2 of U46 and A-connector Pin B24. This provides output of LAST WORD indication to the SD25-182.

Modification of Card A25, Quad DAC (Figure 4): The X½ SCOPE GAIN circuit has been modified to accept a ground lead from switch S1-C of the Model SD25-182. This provides for disabling DAC OFFSET when using the SD25-182. The lead is connected from Card A25 connector 69B to the input of a new U12Δ (piggyback on U12).

Operation of SD360 Unit 2-12

a. Enter data into SD360 on any function and place output memory in HOLD. Then set function thumbswitch to 7 or any time domain function, and press EXECUTE switch.

b. Enter data from output memory to input memory.

1. Place DISPLAY MEMORY INPUT/OUTPUT pushbutton in OUTPUT MEMORY position.

2. Take A and/or B input memory or memories out of HOLD. Refer to page 2 for loading of the selected memory, which can now be accomplished after setting the SD25-182 front panel switches as follows:

A. Set DATA SELECT switch to A or B, as desired.

B. Set MEM HOLD switch as desired.

C. Set RATE switch as desired.

D. Set MODE switch to SINGLE or REP, as desired.

E. Press SINGLE EXEC switch to transfer data.

Model SD25-182 Data Transfer Controller

The Model SD25-182 provides control of data transfer when used in conjunction with the SD360 Unit 2-12 (modified for use with the Model SD25-182). The following figures illustrate the Model SD25-182: Figure 5, Front and Rear Panels; and Figure 6, System Interconnect.

Front Panel Controls

INPUT

DATA SELECT switch

BYPASS	Enables the DSP to operate normally.
A	Selects Channel A data.
B	Selects Channel B data.

MEM HOLD switch

A → A B → B	Enables MEM A data to go into hold when data Channel A is selected, or MEM B data to go into hold when Data Channel B is selected.
A → A • B	Enables MEM A and B both to go into hold when Data Channel A is selected.
	Enables MEM B to go into hold when Data Channel B is selected.

OUTPUT

RATE switch

EXT	Selects the external sample rate from rear Panel Connector J5.
INT	Selects the internal DSP sample rate.

MODE switch

OFF	Selects normal oscilloscope display. No analog output.
SINGLE	Position enables 1024 words to be transferred from DSP output memory to the chosen input memory when the SINGLE EXEC pushbutton is pressed.
REP	Position enables continuous analog output on Connector J8 at the sample frequency rate. No intensity control or retrace blanking; however, transfer of DSP output memory to the chosen input memory only occurs when the SINGLE EXEC pushbutton is pressed.
SINGLE EXEC pushbutton	Press to transfer data from output memory to chosen input memory.

Rear Panel Controls

The rear panel contains connectors only, and are identified as shown in Figure 5.

Operating Concept

The SD25-182 provides the capability to output the contents of the SD360 Output Memory as analog data to an external device or system, in two selectable modes as follows:

On the SD25-182: With the MODE switch at SINGLE, and the OUTPUT RATE switch at INT, the contents of the Output Memory is scanned once at the ADC sampling rate, as set on the analysis range selector switches.

On the SD25-182: With the MODE switch at REPETITIVE, the Output Memory is scanned continuously at the ADC sampling rate; however, transfer to Input Memory takes place when the SINGLE EXEC pushbutton is pressed. The output rate, f_s is given by:

$$f_s = 2.048\ f_{AR}$$

Where f_{AR} = Analysis Range Frequency

The maximum Analysis Range setting is 30,000, which give a maximum output of 61,440 words/sec.

On the SD25-182: With the OUTPUT RATE switch at EXT, the readout rate from the Output Memory is controlled by an external signal. The maximum output rate in the EXT mode is again a nominal 60,000 words/sec.

NOTE

The output scan rate of the SD25-182 is controlled by an internal or external clock signal that should not exceed 60 kHz. If internal is used, this corresponds to an analysis range (on the SD360) of 30 kHz.

The contents of the SD360 Output Memory is used as the excitation signal applied to a system in a single or repetitive mode. The system output signal can then be captured in Channel A Input Memory, using the Transient Capture control on the SD360. A quick comparison between the input excitation waveform and the system response can be made by switching between Memory Input and Output display.

Initially, a time domain waveform is written into Input Memory A or an external signal may be captured and then modified using the Cursor and the Edit feature. The use of Channel A is recommended because data cannot be transferred from Input Memory B to the Output Memory. Time domain data can be transferred directly from Input Memory A to the Output Memory by executing Function 12. The front panel setup for this operation is shown in Figure 7.

MEM Hold Function Description

When toggle switch MEM HOLD is in Position A ⟶A • B, and the DATA SELECT switch is in Position A, pressing the SINGLE EXEC pushbutton causes both input MEM A and B to go into hold after 1024 words have been transferred to Input Memory A from the Digital Signal Processor (DSP) output memory.

When toggle switch MEM HOLD is in Position A ⟶A • B, and the DATA SELECT switch is in Position B, pressing the SINGLE EXEC pushbutton causes MEM B to go into hold after 1024 words have been transferred to Input Memory B from the DSP output memory.

When toggle switch MEM HOLD is in Position $\begin{matrix} A \longrightarrow A \\ B \longrightarrow B \end{matrix}$, and the DATA SELECT switch is in Position A, pressing the SINGLE EXEC pushbutton causes MEM A to go into hold after 1024 words have been transferred to Input Memory A from the DSP output memory.

When toggle switch MEM HOLD is in Position $\begin{matrix} A \longrightarrow A \\ B \longrightarrow B \end{matrix}$, and the DATA SELECT switch is in Position B, pressing the SINGLE EXEC pushbutton causes MEM B to go into hold after 1024 words have been transferred to Input Memory B from the DSP output memory.

NOTE

In the BYPASS mode, the INPUT/MEM HOLD switch should be in Position A ⟶A • B for the DSP to operate normally.

Auxiliary Storage Scope

If the SD25-182 application involves several single scan outputs and Channel A input time domain waveform modification, it is recommended that an auxiliary storage scope be used to capture and display the system output waveform. This will allow the Channel A waveform to be retained in Input Memory for minor editing and subsequent transfer to the Output Memory to use as a new single scan output.

Normal Output Display

The normal output display from the SD360 is a 0-5V signal when the SD25-182 is in the Off mode. Consequently, the zero crossing for a time domain signal is biased at approximately +2.5V. When the single or repetitive mode is used, this bias is removed and the output is bipolar. An offset adjustment on the CRT display may be necessary to view the entire time domain signal in these modes.

Data Transfer Function Description

Interconnection for transfer of data from Output Memory to Input Memory is shown in Figure 6. When operating in this mode, the following steps should be taken:

1. During transfer of data from output memory to input memory the Digital Signal Processor should be placed in the DISPLAY/MEMORY OUTPUT mode.

2. The Y_2 OFFSET control should be adjusted so that Y_2 sweep is superimposed on the Y_1 sweep.

3. Data on the oscilloscope can be observed during transfer by placing the MODE switch on the Model SD25-182 in the REP (repetitive) position.

NOTE: Additional considerations for using the SD25-182 are continued on page 12 of this addendum.

DRAWINGS:

10378700 Single Sweep Control (SD25-182)

10379500 Interconnect Model SD25-182

10359700 Cable Assembly SD360 to SD25-182

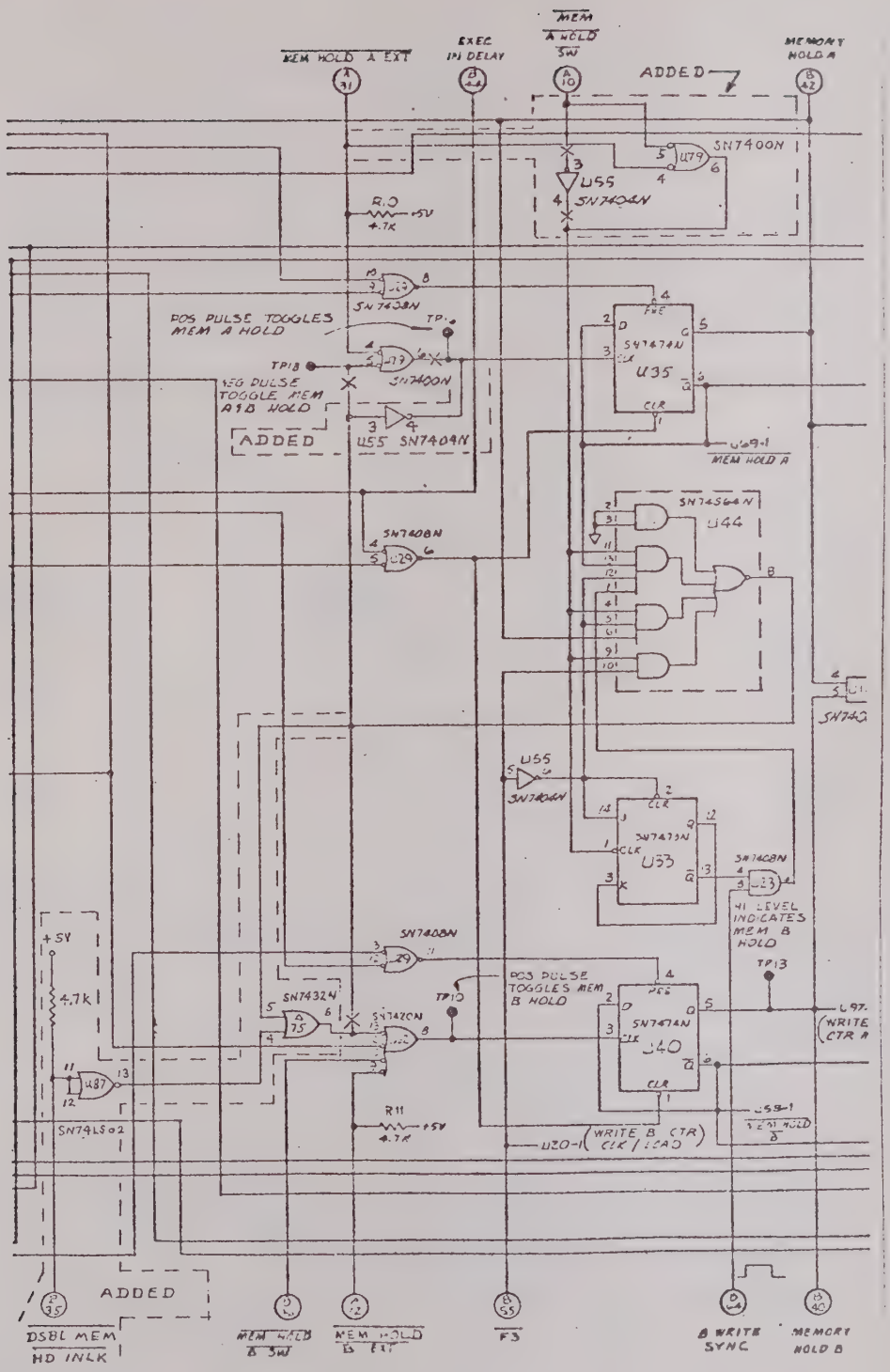


Figure 1. Modification to Card A3, Input Address (Dwg. 10267200)

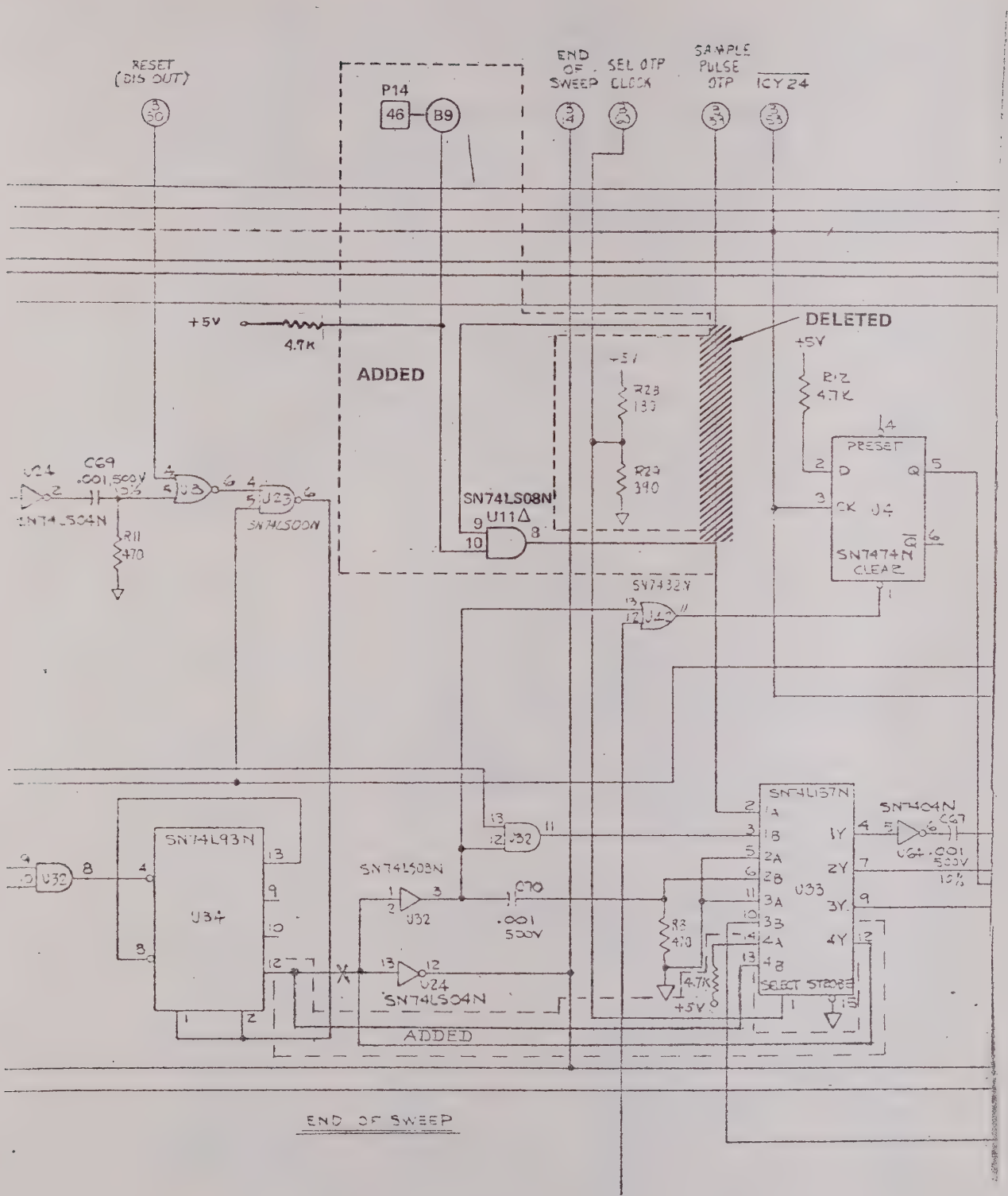


Figure 2. Modification to Card A20, Cursor Control (Dwg. 10269900)

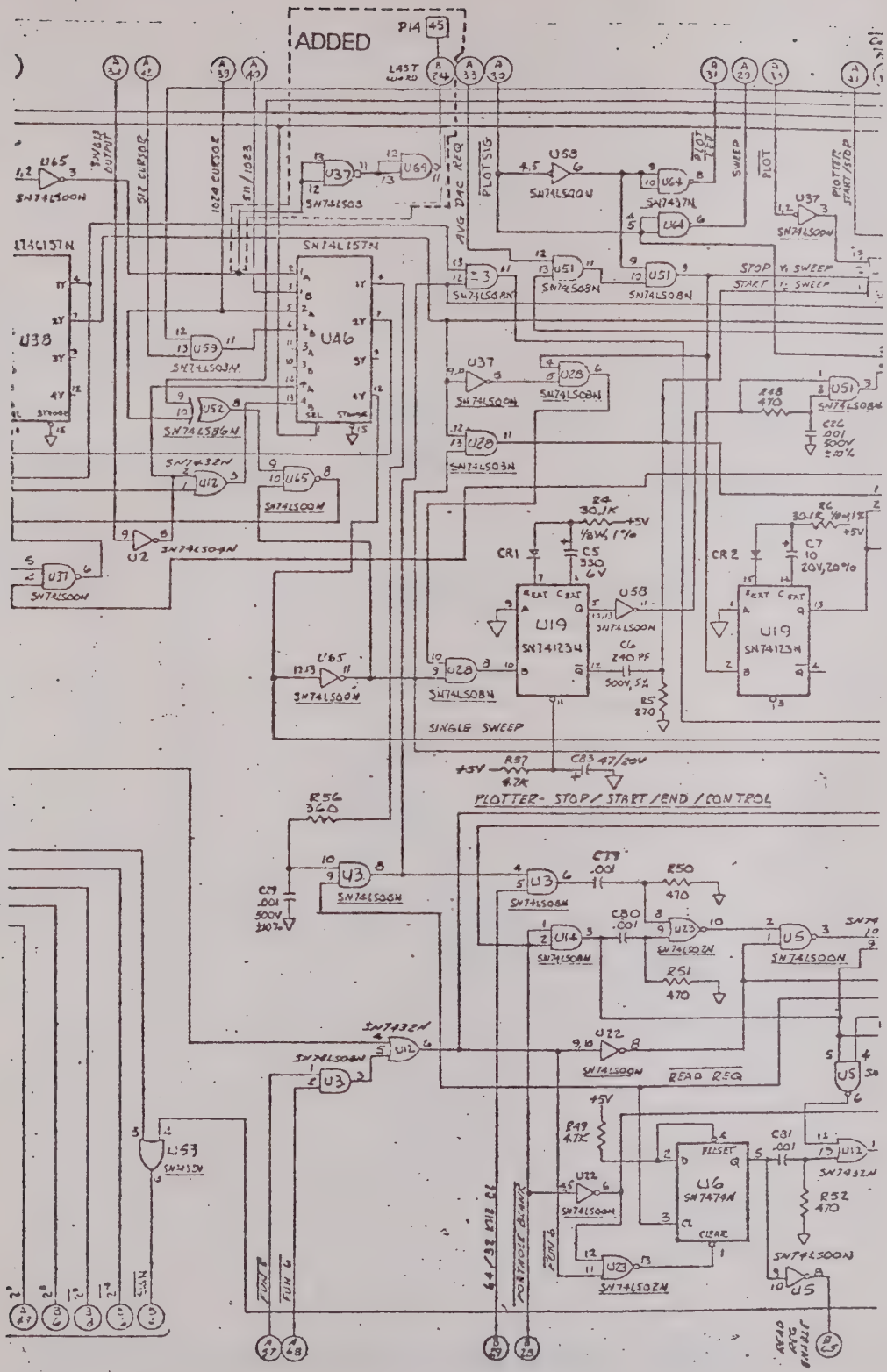


Figure 3. Modification to Card A21, Offset Generator (Dwg. 10271100)

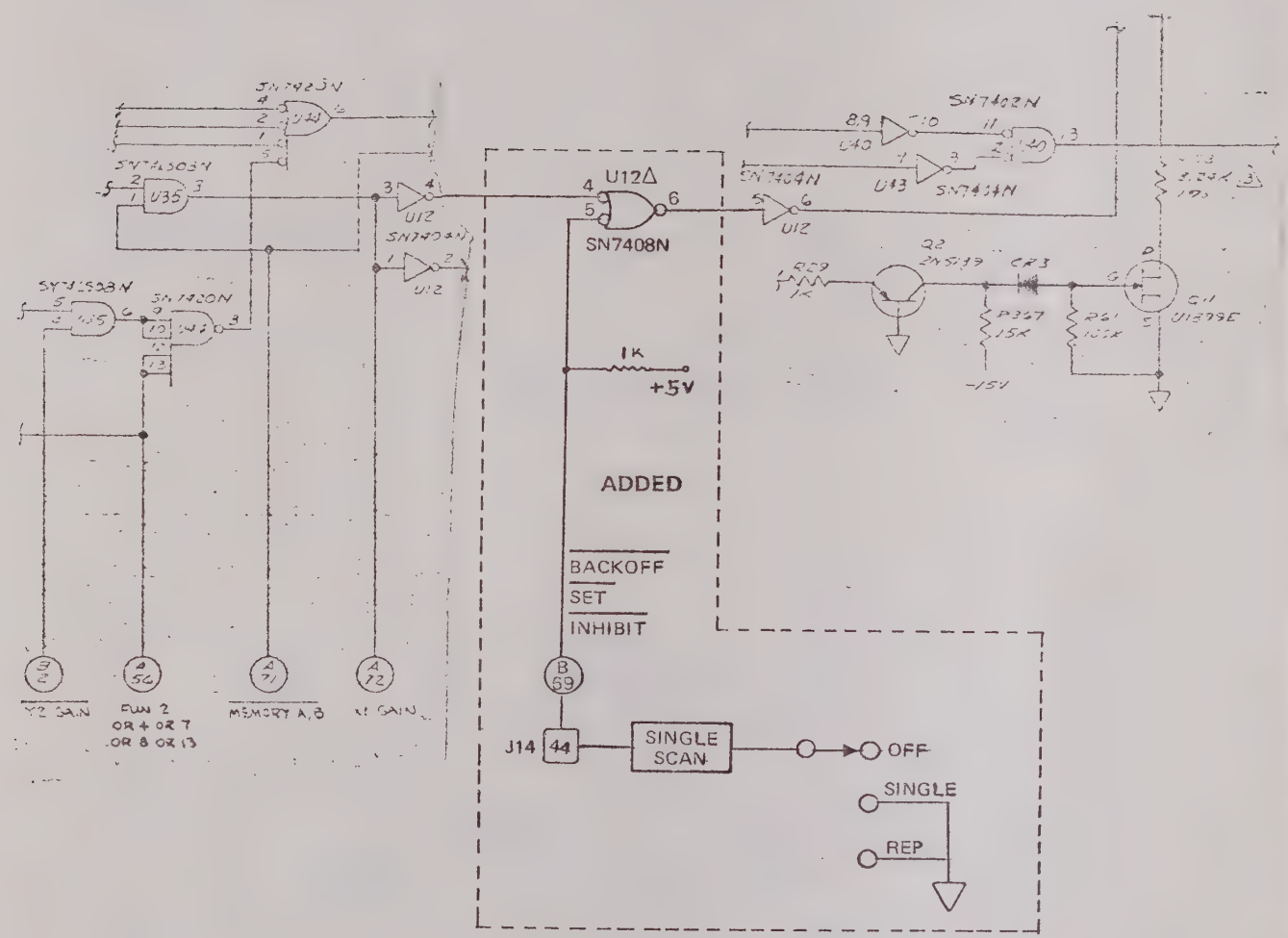


Figure 4. Modification to Card A25, Quad DAC (Dwg. 10304900)

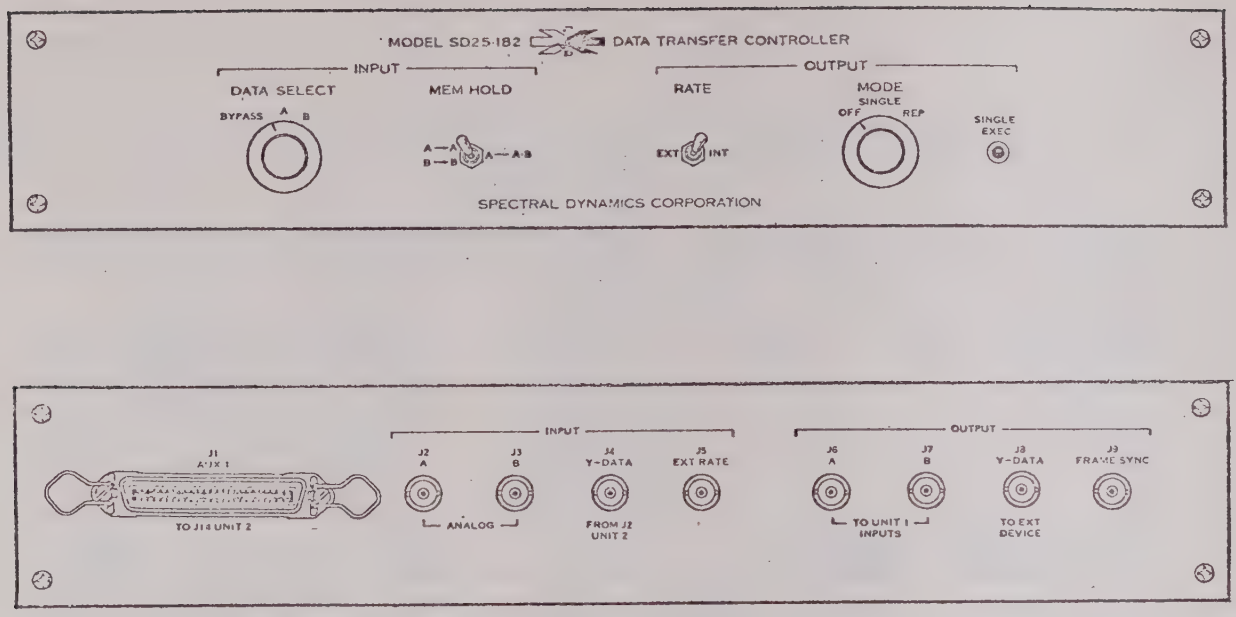


Figure 5. SD25-182 Data Transfer Controller

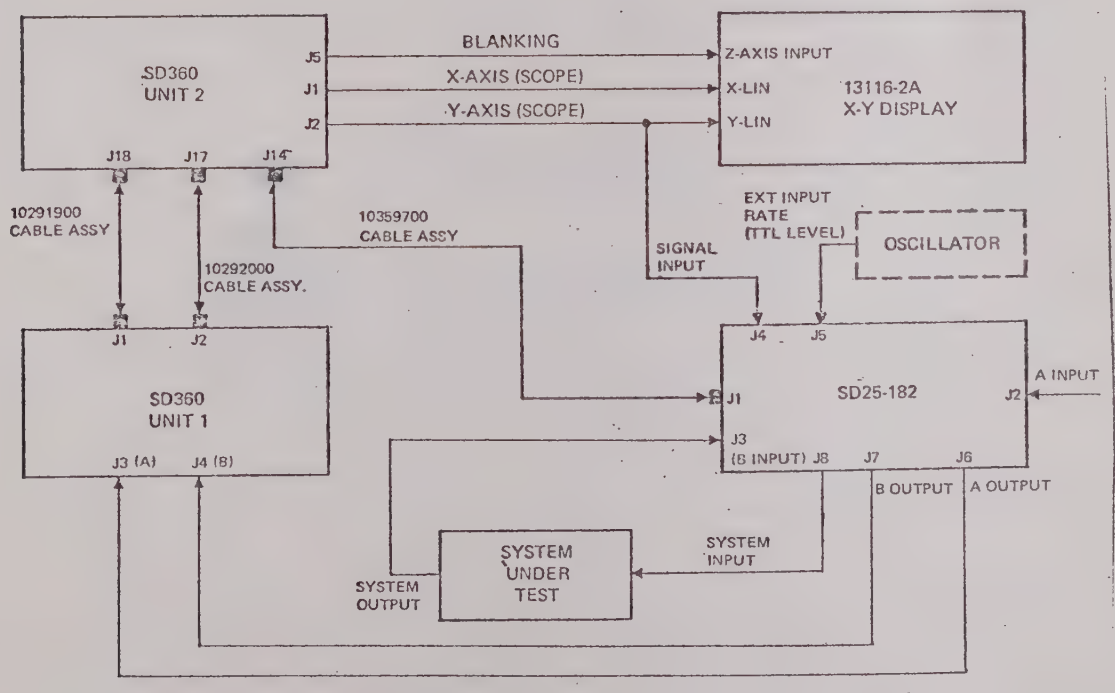
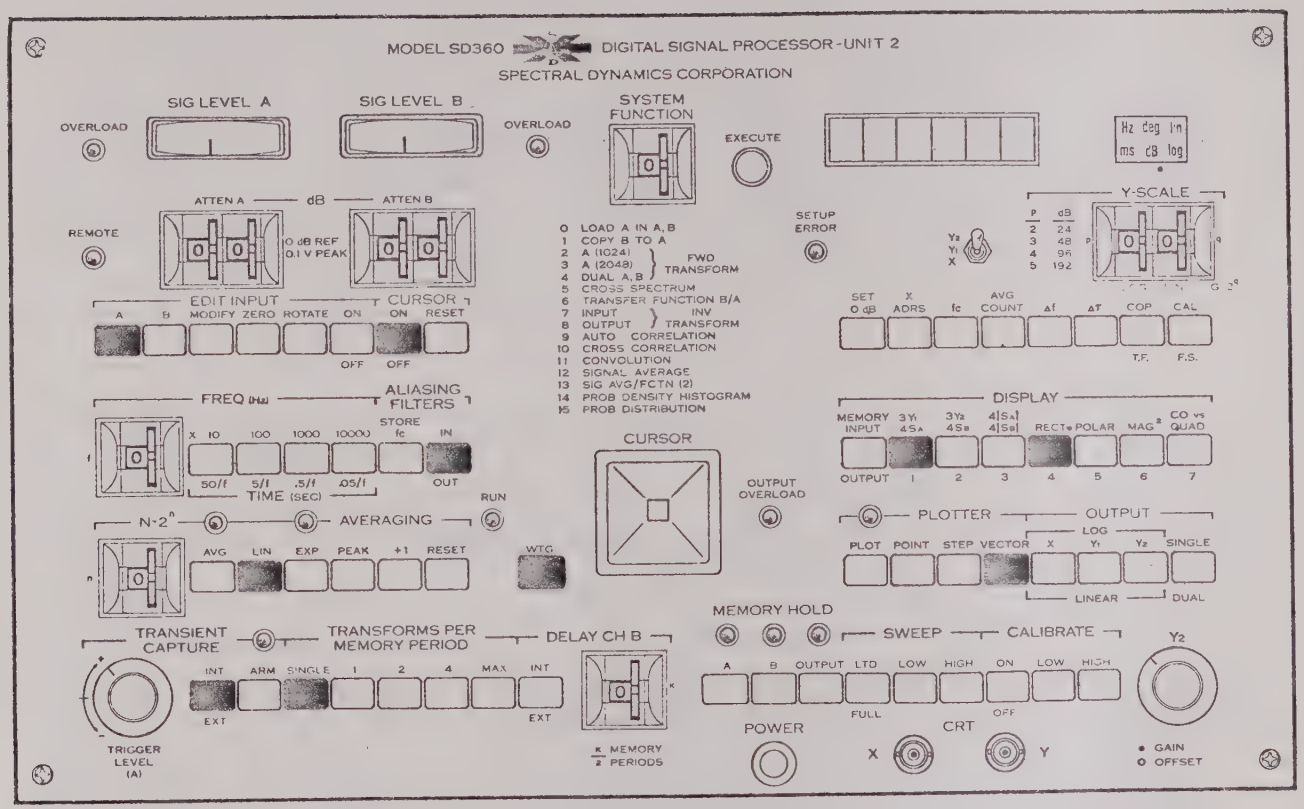


Figure 6. System Interconnect Diagram



LEGEND

SELECTED PUSHBUTTONS

SELECTED THUMBSWITCHES

MOMENTARY PUSHBUTTONS

Figure 7. Function 12 Diagram for Transforming Time Domain Data From Memory A to Output Memory.

Additional Considerations for Using the SD25-182.

In addition to the SD360-12 modification, certain conditions regarding the status of both the input and output memories of the SD360 must be satisfied before the Data Transfer Control unit can be successfully employed. These conditions are especially important if the application involves transferring data from the DSP output memory back to the input memory using the SD25-182 to control the transfer.

The primary item of importance is to be certain that both the DSP output memory and DSP input memory are set up in an operating mode which accommodates data blocks of 1024 words. Although the output memory of the SD360 always contains 1024 words, these are sometimes allocated as 512 real parts, 512 imaginary parts, 512 magnitudes, 512 phases; etc. In general, these "split output memory" conditions are not suitable for data transfer and should, therefore, not be used for this purpose. Similarly, the Processor input memory should be in an operating mode which permits the straightforward loading of data in 1024-word block format. This precludes using operational modes in which unusual data loading characteristics are employed. Thus, the following system functions are not recommended for data transfer operation because of <u>input</u> memory characteristics:

Function 0 - Makes it impossible to independently load Memories A & B.

Function 1 - Could confuse the automatic transfer logic.

Function 3 - Input memories A and B are loaded alternately in this function.

Similarly, Functions 9 and 10 and 11 are not recommended for Data Transfer Operation, although it will work. That is, a correct data transfer will take place into input memory under conditions of System Functions 9 or 10 or 11. However, since half the input memories are effectively zeroed during correlation modes of operation

to avoid circular correlation errors, viewing the input memory following a data transfer may give apparently disappointing results since the righthand portions of both Memories A and B will automatically appear to be zeroes. Nevertheless, any data transferred from output to input under these conditions will successfully be loaded and can either be rotated into the left-half portion of the memory for viewing or the right-half portion of the memory can be "unblanked" by selecting a different system function, such as Function 4, following data transfer.

Note that there are many instances when it is possible to "fool" the input or output display characteristics of the DSP in order to enhance a data transfer. For example, although it is not possible to transfer into the input memory on a normal basis, when the input memory is set up for Function 3, it is nevertheless possible to perform a Function 3, storing the spectrum results in output memory, and then performing a Function 7 simply to prepare the input memory for a normal data load without really changing any characteristics of the data stored in output memory. With this in mind, the following system functions typically create or preserve an output memory format which is optimum for data transfer:

Function 3 - Stores 1024 spectrum magnitudes in either a linear amplitude or log amplitude format.

Function 7 - Stores 1024 time samples of output memory selected from either the even ouput array (display control 1) or the odd output array (display control 2).

Function 8 - Stores 1024 time samples once again chosen from either the even or odd output array.

Function 9 - Stores 1024 correlogram values in output memory which can then be loaded back to input memory, keeping in mind that the right-half portion of input memory will be "apparently blank".

Function 10 - Stores 1024 correlogram values in output memory. This data will often be transferred back into input memory in conjunction with a succeeding convolution operation.

Function 11 - 1024 time samples occurring from a convolution operation can be transferred back to input memory, keeping in mind that the right-half portion of input memory will be "apparently blank".

Function 12 - Time averaged waveforms, representing 1024 time samples, can be transferred back to input memory in a straightforward manner and succeeded by a function 2, thus giving the ability to effectively perform a forward transform on output memory contents.

Function 14 - Transfers 1024 probability density histogram values back to input memory. Keep in mind that these data values are grouped in sections of 8, giving 128 unique amplitude points which are then transferred back to input.

Concept of Operation

The Model SD25-182 Data Transfer Control Unit functions as a timing controller and data transfer regulator. It derives the necessary power supply voltages from the Model SD360 to which it is attached. The Data Transfer Control unit does not contain its own internal storage memory, but acts rather to transfer signals applied to its input terminals. Three basic functions, servicing many various applications, are furnished by the Model SD25-182. These include:

A. Control of independent on common loading of input memories A or B;

B. Adjustment of the DSP output scan rate or output digital/analog converter timing through either internal or external signals; and

C. Transfer of processor data from output memory to input memory.

If the only function to be served by the Data Transfer Control unit is either that of controlling the sequence of loading input memories A and B, or that of controlling the clocking rate of the DSP output memories, no external connections are required and only the use of multi-pin connector cable 10359700 is necessary, such as shown in Figure 6 of this addendum. However, in order to affect complete transfer of data from output memory to input memory, the Y axis data output of the DSP must be connected to the Model SD25-182 as shown in Figure 6. Furthermore, if the Data Transfer Control unit is to be used as an excitation source for driving external systems, then output connector J8 of the Model SD25-182 is connected to the external system input as shown in Figure 6.

Whereas the normal D/A output of the SD360 is a voltage value varying from 0 to +5 volts, when the analog signal output of the DSP is applied through the Data Transfer Control unit prior to driving an external system, the normal 2.5 v d-c offset present on the signal is removed, creating an output voltage swing from 0 to ±2.5 V. For adjusting the output scan rate of the DSP, the MODE control of the Model SD25-182 is set to either the single or repetitive position. If the single position is selected, the output display oscilloscope screen will appear as an intensified spot near the upper end of the display limit until the SINGLE EXECUTE control of the Data Transfer Control unit is depressed. In this mode, each time the SINGLE EXECUTE control is pressed, a single output scan occurs at a rate selected either by the frequency range setting of the DSP (internal clockrate) or by the frequency of the external TTL clocking inputs applied to J5 of the SD25-182. For repetitive modes of output clocking, once again the time base of the output analog waveform can be adjusted either through the frequency range switch of the DSP or through external clocking of the Data Transfer Control unit rate.

One typical application for the Data Transfer Control unit is that of applying to an external system a waveform generated within the

DSP using Function 7 (Inverse Transform from input memory). In this case, if a pure tone free from harmonic distortion is desired, it will be necessary to turn off the Cursor control of the DSP as this tends to produce a constant amplitude point on the output waveform corresponding to the position of the intensified spot. Also, if it is desirable to produce from the DSP a completely distortion-free waveform, it will be necessary to eliminate the effects of memory retrace which occur when the output memory resets from Cell1023 to Cell 0. Retrace effects can be inhibited through rear-panel switch selection, using the "-61" mod. By using this retrace inhibit modification, the output memory becomes truly "circular" minimizing analog output distortion. Note that any time a periodic waveform is created in the SD360 through an inverse transform operation (Function 7), it is automatically periodic in the memory window, with minimum truncation characteristics.

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ADDENDUM

Model SD360 Unit 2-70 Digital Signal Processor

INTRODUCTION

The Model SD360 Unit 2-70 Digital Signal Processor is a standard Model SD360 Unit 2 that has been modified. The "-70" designation added to the basic model number indicates that the unit has been modified to provide a rear-panel switch to inhibit the sweep retrace blanking interval.

The modification is accomplished in the following manner:

1. A two-input AND gate is added to circuit card A20 between U23 pin 6 and U34 pins 1 and 2. U23 pin 6 is one input to the AND gate.

2. Circuit card connector pin, A20-A70, is disconnected from U79 pin 8 and re-connected to the second input of the added AND gate.

3. A toggle switch (S10) is installed on the rear panel in the J10 position and is connected to circuit card connector pin A20-A70. This switch is labeled OFF-RETRACE INHIBIT. In the OFF position, a "1" is applied to the AND gate. In the RETRACE INHIBIT position, a "0" is applied to the AND gate.

OPERATION

Placing S10 in the RETRACE INHIBIT position inhibits the sweep retrace blanking interval for outputting a time function from output memory. Placing S10 in the OFF position restores the sweep retrace blanking circuitry to normal operation. The switch must be in the OFF position when EDIT INPUT is ON.

DRAWINGS

Figure 1 is a partial schematic drawing of the A20 circuit card, showing the circuit changes associated with this modification.

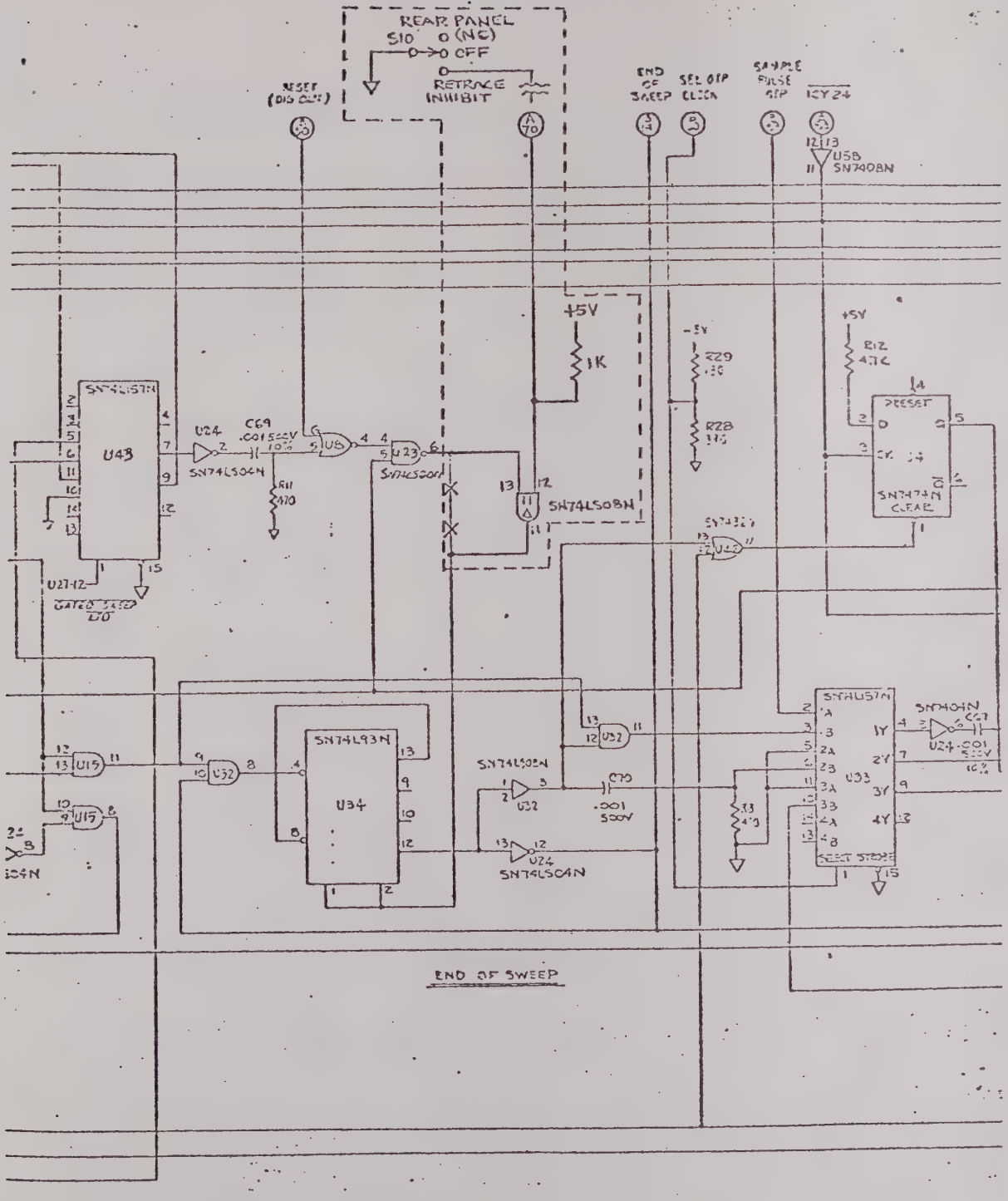

Figure 1. Partial Schematic of A20 Circuit Card.
(Modification enclosed by broken line.)

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RECEIVING INSPECTION PROCEDURE

The Model SD360 Digital Signal Processor is shipped fully assembled, packed in a polystyrene case designed to protect it against all normal shipping hazards. Immediately upon receipt, inspect the exterior of the shipping case and note any visible damage. Keep all forms and invoices attached to the shipping case. Remove the instrument from the shipping case and test its functional operation. If shipping damage is apparent, file a claim with the carrier's claims agent and send a copy to Spectral Dynamics Corporation. Be sure to include the instrument name, model number, and serial number on all correspondence. Spectral Dynamics Corporation will advise the buyer what should be done; arrangements for repair or replacement will be made as applicable.

WARRANTY POLICY

All Spectral Dynamics products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain components listed in some of the operating manuals, for the specified period. We will repair or replace products which prove to be defective during the warranty period, providing the failure or damage has not been caused by misuse or abnormal operating conditions. Fuses and lamps are specifically excluded from warranty. If the malfunction or a portion thereof is determined by Spectral Dynamics Corporation to have been caused by misuse or abnormal conditions of operation, an estimate of cost to repair will be submitted to the purchaser for approval before beginning any repair work.

Liability under this warranty is limited to servicing and adjusting the instrument returned to the factory, with transportation charges prepaid by the purchaser. No other warranty is expressed or implied. We are not liable for consequential damages.

If any malfunction develops, notify Spectral Dynamics Corporation or its representative in your area, giving details of the problem, and the name, model and serial number of the equipment. Upon receipt of this information, service data instructions will be provided.

RETURN SHIPMENT PROCEDURE

On receipt of shipping instructions, forward the instrument prepaid via air freight to the factory or authorized repair station indicated on the instructions. Replace the instrument in its original shipping case, or surround with two to three inches of shock absorbing material and then pack it in a heavy-weight cardbox box, wooden box, or other strong container.

SECTION I

GENERAL DESCRIPTION

1.1 INTRODUCTION

The SD360 Digital Signal Processor (DSP) is a self-contained, stand alone FFT analyzer that looks and operates like an instrument. Its push button controls and thumbwheel switches are logically grouped for maximum flexibility and operating convenience.

The DSP is packaged in two units. Dual-channel input signal conditioning, anti-aliasing filters and A/D converters are contained in Unit 1. Front-panel controls, input/output/processor memories, CPU, microprogram ROMs, weighting function and math table ROMs and output control are contained in Unit 2. A simplified block diagram of the DSP is shown in Figure 1-1. In Unit 2, all data is processed in digital form.

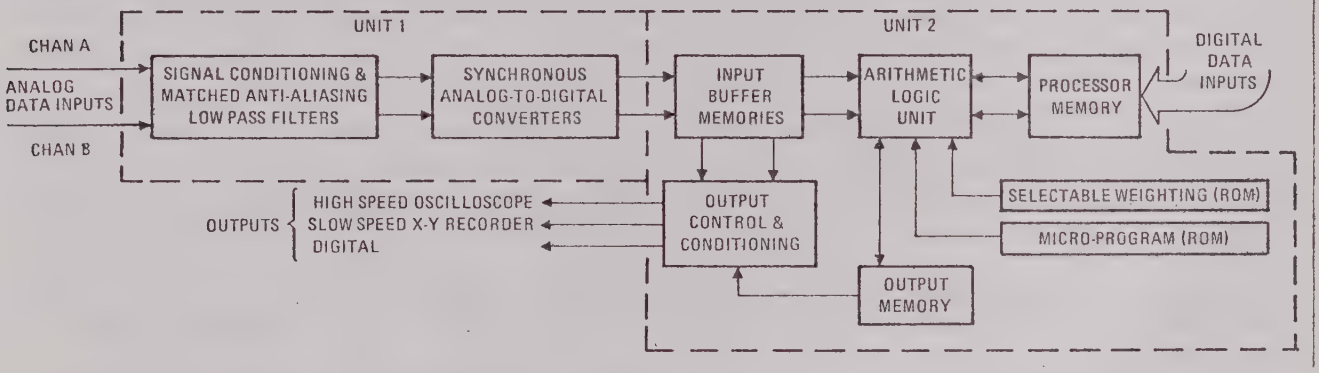


Figure 1-1. DSP Simplified Block Diagram

In remote control mode, the DSP can also be used as a peripheral processor in a computer controlled system. The DSP as a system building block is shown in Figure 1-2.

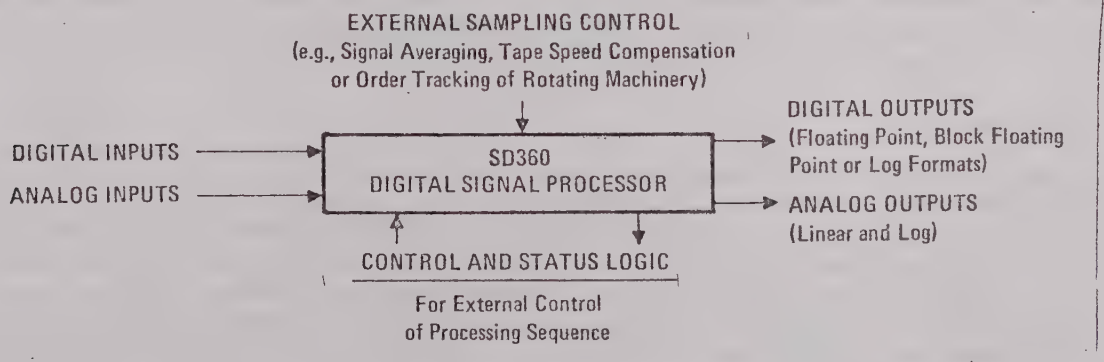

EXTERNAL SAMPLING CONTROL
(e.g., Signal Averaging, Tape Speed Compensation or Order Tracking of Rotating Machinery)
DIGITAL INPUTS
ANALOG INPUTS
SD360 DIGITAL SIGNAL PROCESSOR
DIGITAL OUTPUTS
(Floating Point, Block Floating Point or Log Formats)
ANALOG OUTPUTS
(Linear and Log)
CONTROL AND STATUS LOGIC
For External Control of Processing Sequence

Figure 1-2. The DSP As A System Building Block

The power supply in Unit 1 is of conventional design utilizing a 50/60-Hz power transformer. The power supply in Unit 2 is of state-of-the-art design utilizing a high frequency switching-type regulator for high efficiency and minimum size and weight.

1.2 DSP CHARACTERISTICS

There are 16 system functions available in the DSP, each of which can be operated in a variety of configurations. Some of the possible variations are as follows:

- Signal level
- Analysis range
- Anti-aliasing filter in or out
- Weighting in or out
- Averaging in or out
- Transform rate
- Coordinate conversion
- Linear or log output
- Transient capture
- Input data editing
- Sweep limiting

There are standard setup configurations for the most commonly used functions which are almost self-explanatory from the front panel labels. These permit an operator to get useful data from the DSP almost immediately. As one becomes more familiar with the controls, the built-in flexibility will become more apparent so that a much larger variety of configurations can be usefully employed.

It is inevitable, initially, that invalid switch combinations will be set up. A setup error light is provided to assist in setting up correct configurations.

A 2-axis cursor control is provided for edit control, locating specific data, setting reference points and high and low sweep limits.

A 6-digit LED display is provided to read out data values in engineering units at the cursor position. The correct units to go with the numerical value are shown in a box to the right of the LED display.

Each time the System Function switch is changed, the EXECUTE push button must be pushed in order to set up the microprogram sequence to execute the selected function.

1.3 DESCRIPTION

The DSP can be conveniently divided into three major sections: input, CPU and output. The input section is located in Unit 1; CPU and output sections in Unit 2. The three sections are controlled from the front panel of Unit 2 through appropriate control circuitry. Analog input data is conditioned, digitized and written into input memory. All subsequent processing is handled digitally. Digital-to-analog converters are used to generate analog output signals for the CRT and X-Y plotter.

1.3.1 Input Section

The input section in Unit 1 is comprised of two identical channels of analog signal conditioning, switchable anti-aliasing filters and 12-bit A/D converters, The front-panel attenuators control the gain of the input amplifiers over the range of 69 dB in 1 dB steps. With an input attenuator setting of 0 dB, a 0.1 volt peak input signal will be amplified to a 5.0 volt peak level signal for input to the A/D converters. With a maximum input signal level of 12.6 volts peak and an attenuator setting of –42 dB, the signal level into the A/D converters will be 5.0 volts peak. Input signals greater than 12.6 volts peak are limited and will thus be distorted. The input overload lights turn on when the six most significant bits, not including the sign, are all 1's for a positive value or all 0's for a negative signal. As a result, the overload lights turn on when the peak input signal level is at 98.5 percent of full scale. The cutoff frequency of the anti-aliasing filters is controlled by settings of the analysis range switches and is always 0.75 of the analysis range. When the STORE f_c push button is in, the filter cutoff frequency is stored. Subsequent changes in the analysis range will not change the filter cutoff frequency until the STORE f_c push button is out.

1.3.2 CPU Section

The CPU section is comprised of the input, processor and output memories, the arithmetic logic unit (ALU), the floating point unit (FPU) and all of the ROMs which contain the microprogram, microprogram control, mathematical tables for the sine, cosine, division, square root, arctangent and weighting functions, and the averaging coefficients. The elements of the CPU are organized around 4 data buses and an exponent bus. The ALU is made up of four multipliers and six adders to efficiently perform complex arithmetic operations. All numerical data processing operations except log conversion are handled by the CPU. These include the Fast Fourier Transform (FFT), rectangular to polar coordinate conversion, averaging and all other processing operations for all the system functions.

1.3.3 Output Section

The output section reads data from the output memory, normalizes the floating point data, performs log conversion when selected and outputs the data through a digital to analog converter for CRT display. In this mode, the output memory is used as the CRT refresh buffer. Other functions performed by the output section are engineering unit conversion for the LED display, baseline clipping, linear gain control, log offset, log Y range control, single or dual trace display, CO/QUAD display, output calibration, sweep limit control, plotter mode control and digital output to an external minicomputer.

1.3.4 Control Section

The control section, so called, is not a discrete entity, but is distributed throughout the machine. Front panel push buttons and switch settings for signal processing are decoded to select the microprogram sequences that control the CPU operations. The analysis range switches control the A/D converter sampling rate and also the anti-aliasing filter cutoff frequency. The display control switch settings are used in both the CPU and output sections to control array processing for output conversion and the various display options.

1.4 SPECIFICATIONS

INPUTS

ANALOG

Frequency Ranges
57 built-in ranges from 10 Hz full scale to 150 kHz full scale in integer steps of 1 through 15 with multipliers of 10, 100, 1000 and 10,000.

Sensitivity
0.1 volts peak minimum full scale signal level
12.6 volts peak maximum full scale signal level
50 volts peak maximum overload signal level

Input Attenuation
0–69 dB in 1 dB steps, each channel

Coupling
Selectable ac/dc. AC coupling down 3 dB at nominal 0.47 Hz.

Level Indication
Input monitor meter with overload light on each channel

Input Impedance
>100 kΩ

Dynamic Range
>70 dB, full scale to minimum discernible signal each channel for forward transform

DIGITAL
16-bit 2's complement, TTL logic

OUTPUTS

ANALOG

"Simulplot" feature permits simultaneous display of data on oscilloscope and recording on X-Y plotter under cursor control.

X Axis
- linear . . . . . 0-5V full scale
- log . . . . . 5V full scale

Y_1 Axis
- linear . . . . . 0-5V full scale
- log . . . . . 5V full scale

Y_2 Axis (adjustable)
- linear . . . . . 0-1V full scale Min
  0-5V full scale max.
- log . . . . . 1V full scale min.
  5V full scale max.
- offset . . . . . ±5.5V ,

Output Impedance
Nominal 100Ω

Non-linearity
<±0.1% full scale, best straight line on both X and Y axes.

Log Display Range
24, 48, 96 or 192 dB (ranges can be offset >180 dB to provide zoom-in capability; offset can be displayed on LED readout)

Baseline Clipping
From –93 dB to –51 dB in 3 dB steps

Output Gain
Up to 32,768 in binary steps
(Gain = 2^q where q = 0, 1, ... 15)

X-Y Recording Modes
- Point Plot: . . . . . Output to point plotter
- Step*: . . . . . Draws histogram-type plot on standard X-Y recorder.
- Vector*: . . . . . Draws straight line between data points on standard X-Y recorder.

*Recorder is incremented under constant-velocity control to eliminate overshoot. Internal selection of maximum velocity over a 250-to-1 range provided to match the response of the recorder used.

DIGITAL

Three selectable formats, all using 16-bit, 2's complement, TTL logic.

Floating Point
Data transferred in two words:
1st word is 16-bit fraction including sign
2nd word contains 7-bit exponent (excess 64)

Block Floating Point
16-bit fraction including sign. The single exponent for the fraction block is transferred separately.

Log
7-bit characteristic (excess 64) and 8-bit mantissa for each calculated point.

System Functions

Forward Fourier Transform, 1 x 1024
Forward Fourier Transform, 1 x 2048
Dual Forward Fourier Transform, 2 x 1024
Power Spectrum (Mag^2 of Forward Fourier Transform)
Cross Spectrum
Transfer Function
Coherent Output Power
Inverse Fourier Transform of Input Data
Inverse Fourier Transform of Output Data
Autocorrelation
Cross-Correlation
Convolution
Signal Averaging
Signal Averaging, Forward Transform
Probability Density Histogram
Probability Distribution

Input A/D Conversion

12 bits each channel

Input Anti-Aliasing Filters

Matched anti-aliasing filters with initial roll off 66 dB/octave. Selectable IN or OUT by front panel switch. Filters are automatically selected with the frequency range or can be stored at any of 57 cut-off frequencies independent of the analysis frequency range.

Filters can be cascaded to obtain an initial roll-off of 132 dB/octave when processing only one channel of data.

Transient Capture

Upon triggering of the transient capture mode, 88% of the memory is loaded with new data. The leading edge of the transient (12% of memory) is preserved.

Trigger Int/Ext

Loading of transient data can be initiated from an external analog or digital signal or from a threshold crossing of the signal level of channel A. The ± threshold level is adjustable from the front panel and can be displayed on a CRT as an overlay with the incoming data of channel A.

Precomputation Delay

(System Function 5 and 10 only)

Int – Loading of channel B is delayed up to 7-1/2 memory periods in 1/2 memory period steps.
Ext – Loading of channel B is initiated after desired delay by TTL-compatible pulse

Input Editing

Data in input buffer memories A and/or B can be edited under cursor control
Three editing functions provided: (See 2.2.3)

Modify – Data value at any address location is changed via 2-axis joystick control of the cursor.
Zero – Memory is reset to zero at the cursor position.
Rotate – Contents of memory are shifted right or left via CURSOR control.

Transform Size

Single channel 1024 or 2048 points of input data.
Dual channel 1024 points each channel of input data.

Transform Time (Rect. coordinates)

Single channel 1024 point – 30 milliseconds nominal.
Single channel 2048 point – 40 milliseconds nominal.
Dual channel 1024 points each channel – 32 milliseconds nominal.

Sampling Rate
Internal — 2.048 x frequency range selected
External — Controlled by TTL compatible pulses from external source
Maximum Sampling Rate — 307.2 kHz

Weighting
Selectable Kaiser-Bessel or rectangular time domain weighting (other symmetrical weighting functions optional, using 8 plug-in ROMs)

Memory Hold
Each input memory and the output memory can be held independently. Manual or External TTL input control.

Transform Rate
Front panel selection of single or continuous processing at rates of 1, 2 or 4 transforms per memory period, up to the real-time limit as well as at MAX rate for the processing function.

Averaging Modes
(frequency or time domain data)
Linear averaging up to 4096 ensembles
Exponential (running) averaging
Peak-hold
+1(add one) averaging in all above modes.

Sweep Limit
Upper and lower sweep limits can be set from the front panel to limit the x-axis display to any portion of the total range. Limits operate for any selected function and for both analog and digital output. Upper limit set only on System Functions 5, 6 and 15.

Frame Sync
128 μ sec TTL logic pulse to synchronize external device with memory.

Pen Lift
SPST relay contact closure provided to lower the pen on an X-Y plotter when the PLOT light is on.

Word Sync
2 μsec TTL logic pulse as each word is strobed into the output DAC

Cursor Pulse
128 μsec TTL pulse corresponding to cursor location on CRT display.

LED Readout
6-digit display will indicate the following processing parameters and results: (See 2.2.15)

Anti-aliasing filter cut-off frequency f_c
Frequency interval Δf between adjacent address locations
Time interval Δf between adjacent address locations
Averaging ensemble counts
Relative offset of log display
X-address in memory*
Frequency (Hertz)*
Time (milliseconds)*
Phase Angle (degrees)*
Relative log amplitude (dB)*
Normalized linear amplitude*

*At cursor location

Calibration
Internal CAL/F.S. square wave, input selectable before (CAL) or after (F.S.) input attenuators. (Selecting F.S. gives normalized full-scale calibration independent of input attenuator setting.)

Calibration Steps

Y-Axis Calibration

Log: Normalized calibration: 0 dB using CALIBRATE HIGH and –20, –40, –80 and –160 dB using p-switch, or 1 dB steps using input attenuators.

Linear: Normalized — zero and full scale or 1 dB steps using input attenuators.

X-Axis Calibration

Log: Full scale and –2 decade or any desired frequency point via cursor.

Linear: Full scale and zero, or any desired calibration point in between via cursor. Full scale is X-Address 500 on System Function 1 and 1000 on System Function 3.

Dimensions

Unit 1 data

Height . . . . . 14 cm (5½")
Width . . . . . 43, 18 cm (17")
(Rack-Adapter Tabs Supplied)
Depth . . . . . 53, 34 cm (21")
Weight . . . . . 8, 2 kg (18 lb.)

Unit 2 data

Height . . . . . 26.67 cm (10-1/2")
Width . . . . . 43, 18 cm (17")
(rack-adapter tabs supplied)
Depth . . . . . 53, 34 cm (21")
Weight . . . . . approx. 29.5 kg (65 lb)

SECTION II
CONTROLS AND OPERATION DESCRIPTION

2.1 INTRODUCTION

This section provides a description of the controls of the DSP. Its purpose is to familiarize an operator with the functions of the front panel control groups. No attempt is made here to describe each push button or switch; see Appendix A for that information. Rather the intent is to help the operator to understand the functions of the various groups of controls. A series of front panel set-ups and operation procedures is then presented to further clarify the use of the front panel controls. These set-ups and procedures also serve as a brief operational check-out for the DSP.

2.2 FRONT PANEL CONTROL GROUPS

The front panel controls of the DSP are arranged into groups according to the functions performed. The following paragraphs describe the functions of the various groups of controls. Each group is illustrated to facilitate the description. All controls are located on Unit 2 unless otherwise indicated.

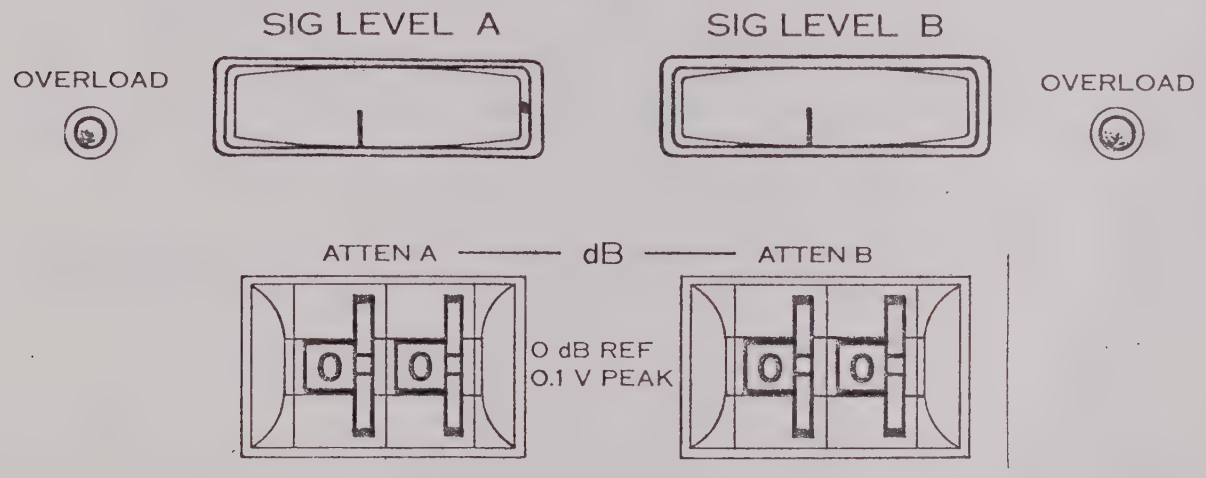


Figure 2-1. Signal Level Group

2.2.1 Signal Level Group

Refer to Figure 2-1. The signal level group controls and monitors the peak input signal voltage level to the A/D converters. These attenuator controls permit adjusting the input signal to the desired level. Separate signal level meters, overload indicators and attenuation controls are provided for each of two independent input data signals.

Figure 2-2. REMOTE Indicator

2.2.2 REMOTE Indicator

Refer to Figure 2-2. The REMOTE indicator light turns on when the DSP is under remote control. Remote control is selected by a positive true logic level into rear panel connector COMPUTER 1.

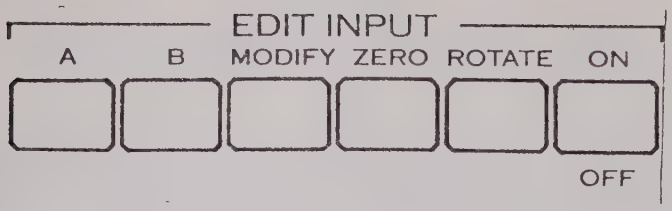


Figure 2-3. Edit Input Group

2.2.3 Edit Input Group

Refer to Figure 2-3. The edit input group of push buttons selects the type of edit function to be performed on data stored in either or both of the input memories. The input memory to be edited must be placed in MEMORY HOLD. All editing functions are performed under CURSOR control. Edit functions available are:

- Modify the data value in input memory at the cursor position
- Zero the data value in input memory at the cursor position
- Rotate the data value in input memory at the cursor position

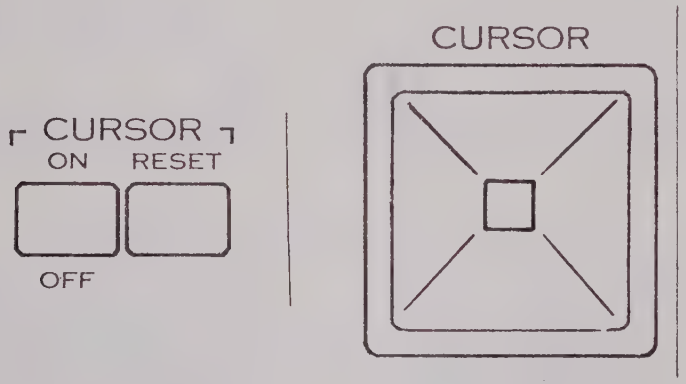


Figure 2-4. Cursor Group

2.2.4 Cursor Group

Refer to Figure 2-4. The cursor group includes the labeled push buttons and the CURSOR control.

NOTE

In this manual, the word "cursor" is used as follows:

- "CURSOR" refers to the front panel two-axis CURSOR control (joystick).
- "CURSOR ON/OFF" and "CURSOR RESET" refer to the front panel push buttons.
- "Cursor" refers to the bright dot on the CRT display.

Functions of the cursor group include the following:

a. Locating specific data points for LED readout.
b. Edit control on data stored in either or both input memories.
c. Setting 0 dB reference.
d. Setting high and low sweep limits for LTD sweep.

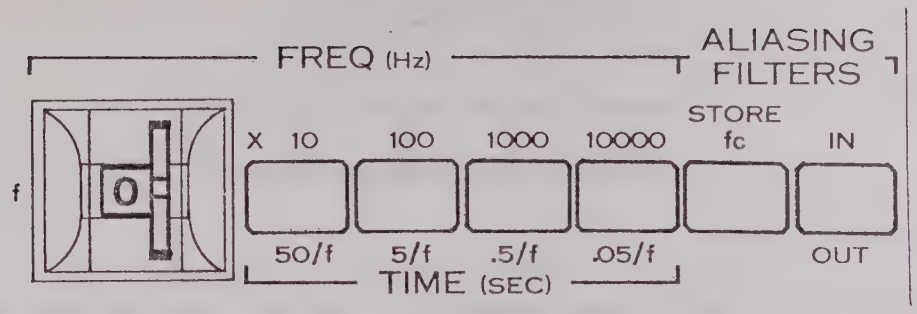


Figure 2-5. Analysis Range Group

2.2.5 Analysis Range Group

Refer to Figure 2-5. The analysis range group includes the controls to select the analysis frequency range and the controls for the aliasing filters. In normal operation, the proper aliasing filter for each analysis range is selected automatically when the frequency range is selected. Pressing in the STORE f_c push button holds the aliasing filter cutoff frequency fixed, independent of other analysis range switch settings. Selection of an analysis range also automatically selects the correct sampling frequency. The sampling frequency (f_s) for any analysis range can be determined by multiplying the product of the switch settings by 2.048. The Nyquist frequency (2 samples/cycle) is equal to one half the sampling rate, which is $f_s/2$.

The memory period (time required to write 1024 words into input memory) is given by the ratio under push buttons which are grouped as TIME (SEC), where f is the setting of the f-switch.

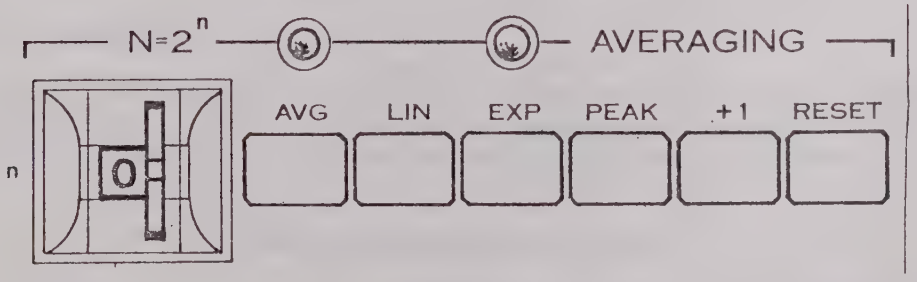


Figure 2-6. Averaging Group

2.2.6 Averaging Group

Refer to Figure 2-6. The averaging group controls the process of digitally filtering input or output ensembles to provide signal-to-noise enhancement. In LIN averaging, the number of ensembles averaged can be varied by 1 to 4096 in integer powers of two, as selected on the n-switch. In EXP averaging, the setting of the n-switch controls the averaging "time constant" in integer powers of two. PEAK hold runs continuously as long as the AVG indicator is on, and is not affected by the n-switch setting. The +1 push button permits adding one ensemble in LIN, EXP or PEAK hold modes. The RESET push button resets the ensemble counter to zero and takes the CPU out of the averaging mode.

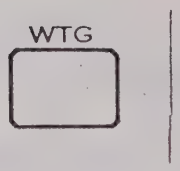


Figure 2-7. Weighting Push Button

2.2.7 Weighting Push Button

Refer to Figure 2-7. When the WTG push button is in, Kaiser-Bessel weighting from internal ROMs is applied to the input data during transfer from input memory to processor memory, for those functions with which it can be used. When the WTG push button is out, rectangular weighting is applied.

Figure 2-8. RUN Indicator

2.2.8 RUN Indicator

Refer to Figure 2-8. The RUN indicator turns on whenever the CPU is executing a system function and is off otherwise. During normal operation on most analysis ranges, the RUN indicator will appear to be on continuously.

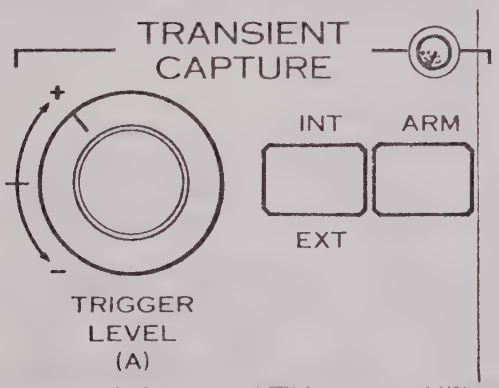


Figure 2-9. Transient Capture Group

2.2.9 Transient Capture Group

Refer to Figure 2-9. The transient capture group is enabled when the TRANSFORMS PER MEMORY PERIOD SINGLE push button (Figure 2-10) is in. Before transient capture is initiated, data is continuously being written into input memory. When transient capture is initiated at time t_0, approximately 88 percent new data is loaded into input memory, then loading stops and input memory automatically goes into MEMORY HOLD. The other 12 percent of the data in input memory was written prior to time t_0. Relative address zero in input memory contains the first (oldest) word of the complete time series sequence. The data stored in input memory can be edited and processed as desired.

Transient capture triggering is selected by the INT/EXT and ARM push buttons and the TRIGGER LEVEL control. A trigger pulse can be generated when the input signal exceeds a triggering threshold, by an external analog or digital timing signal or manual operation of the EXECUTE push button (Figure 2-13).

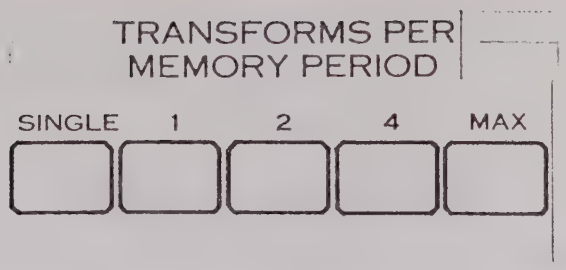


Figure 2-10. Transforms Per Memory Period Group

2.2.10 Transforms Per Memory Period Group.

Refer to Figure 2-10. The transforms per memory period group controls the number of transforms that are executed during one memory period.

When the number of transforms selected exceeds the maximum real time rate, the maximum number will be executed.

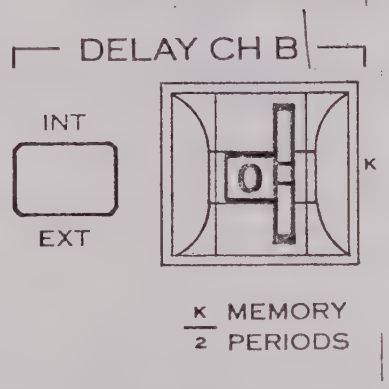


Figure 2-11. Delay Channel B Group

2.2.11 Delay Channel B Group

Refer to Figure 2-11. The delay channel B group provides a delay in loading input data into input memory B with respect to memory A, either as an automatic delay or in conjunction with the transient capture controls. This group is active only for the cross-correlation and cross-spectrum system functions 5 and 10.

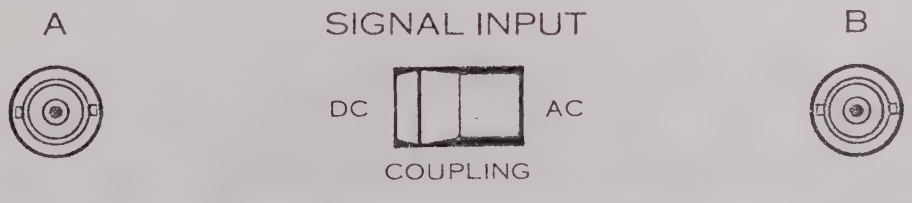


Figure 2-12. Signal Input Group (Unit 1)

2.2.12 Signal Input Group (Unit 1)

Refer to Figure 2-12. The signal input group accepts the channel A and channel B input data signals. These front panel connectors parallel the corresponding rear panel connectors. The DC/AC coupling switch controls both channels simultaneously.

Figure 2-13. EXECUTE Push Button

2.2.13 EXECUTE Push Button

Refer to Figure 2-13. Pressing the EXECUTE push button generates a master start pulse which loads the proper microprogram subroutine sequence for the CPU according to the front panel push button configuration. Whenever a different system function is selected, the EXECUTE push button must be pressed in order to load the proper microprograms.

Figure 2-14. SETUP ERROR Indicator

2.2.14 SETUP ERROR Indicator.

Refer to Figure 2-14. The SETUP ERROR indicator lights when the front panel switch configuration is incorrect.

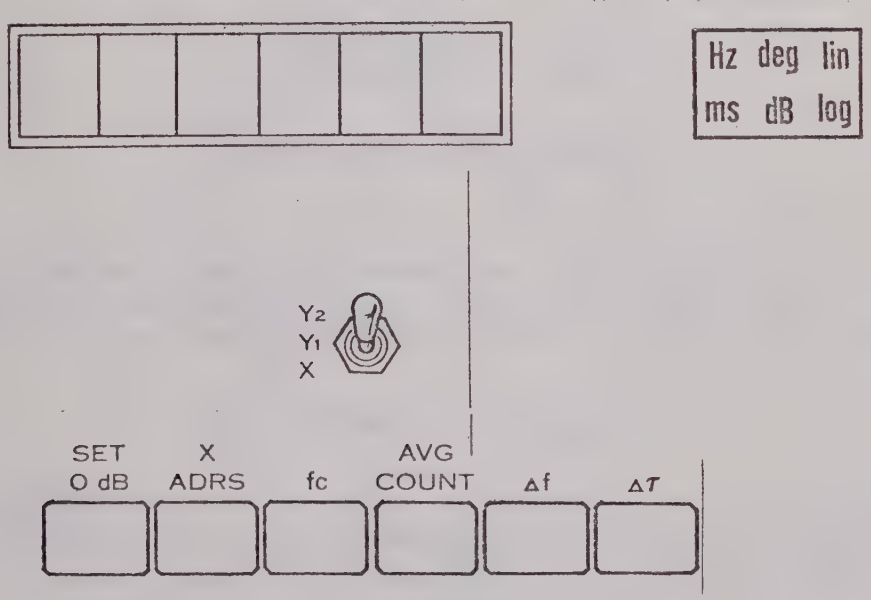


Figure 2-15. LED Display Control and Indicator Group

2.2.15 LED Display, Control and Indicator Group

Refer to Figure 2-15. The LED display is a 6-decimal digit numeric readout of X or Y-axis data, as follows:

- Frequency at cursor location
- Time at cursor location

- Cursor X-axis address
- Y-axis log magnitude in dB for either Y1 or Y2
- Y-axis relative magnitude for either Y1 or Y2
- Phase angle in degrees
- Aliasing filter cutoff frequency f_c
- Value in the ensemble counter
- Frequency interval Δf between adjacent address locations
- Time interval $\Delta\tau$ between adjacent address locations

Data in the LED display is controlled by the CURSOR. A section of the units indicator lights to show the proper engineering units to associate with the digital value on the LED display.

With a log display in dB, pressing the SET 0 dB push button will set the LED display to read 0 dB at the cursor position. Values at any other cursor position will read directly in dB relative to the stored 0 dB reference.

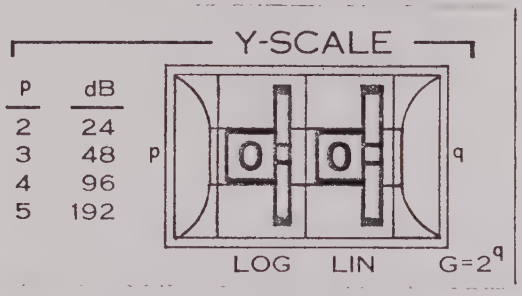


Figure 2-16. Y-Scale Group

2.2.16 Y-Scale Group

Refer to Figure 2-16. The Y-Scale Group controls linear and logarithmic Y-axis zero scale to full scale value. The p-switch controls the number of bits (2-5) in the characteristic of the digital log output to the digital-to-analog converters. In LIN mode, the q-switch controls the Y1 and Y2-axis linear digital output gain ($G = 2^q$ for $q = 0, 1 \ldots, 15$), for vertical scale expansion for the oscilloscope display. In LOG display mode, the q-switch provides baseline clipping on the CRT display from –93 dB to –51 dB in 3 dB steps.

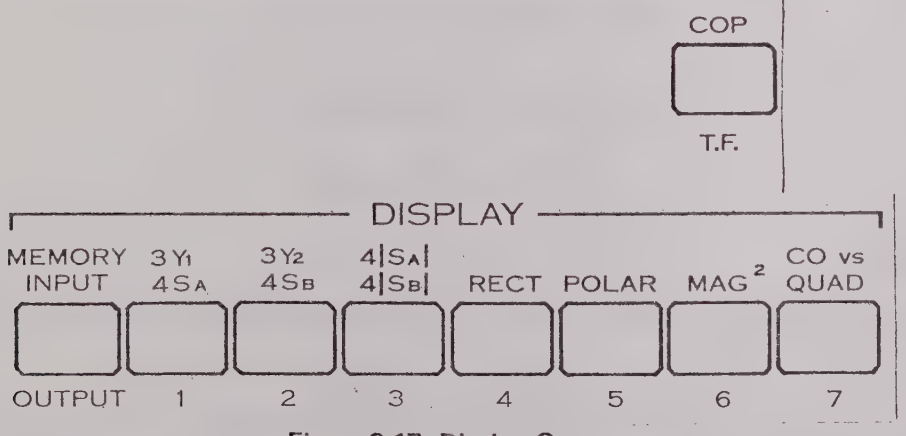


Figure 2-17. Display Group

2.2.17 Display Group

Refer to Figure 2-17. The display group selects input data stored in the input memories or transformed data stored in the output memory for oscilloscope display. This group also selects the coordinate system used in

display of transformed data. In addition to the rectangular coordinates used in display of time domain data from the input memories, the following frequency domain coordinate systems are available for displaying transformed data:

- Rectangular, with the transformed real and imaginary data displayed separately.
- Polar, with the magnitude and phase data displayed separately.
- MAG^2, with the magnitude^2 and phase data displayed separately.
- Coincident versus quadrature, with the real and imaginary data displayed on X and Y-axes, respectively.

Push buttons labeled 1-7 control a larger number of display formats and options than can be conveniently labeled on the front panel. See Appendix A for combinations.

Figure 2-18. OUTPUT OVERLOAD Indicator

2.2.18 OUTPUT OVERLOAD Indicator

Refer to Figure 2-18. The OUTPUT OVERLOAD indicator light turns on when the digital output data is over-range.

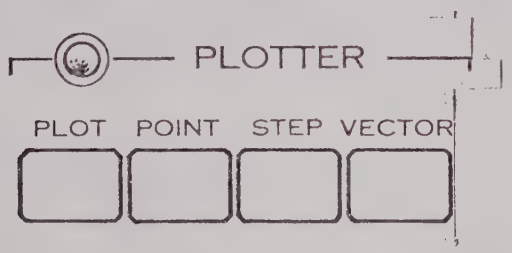


Figure 2-19. Plotter Group

2.2.19 Plotter Group

Refer to Figure 2-19. The plotter group is used to control data output to an X-Y recorder. The data can be plotted in three forms:

- Point plotting, with the data recorded in discrete points.
- Step plotting, where the X-axis increment is plotted followed by the Y-axis increment under constant velocity control.
- Vector plotting, which plots straight lines between consecutive points under constant velocity control.

Plotting is done simultaneously with CRT display under CURSOR control.

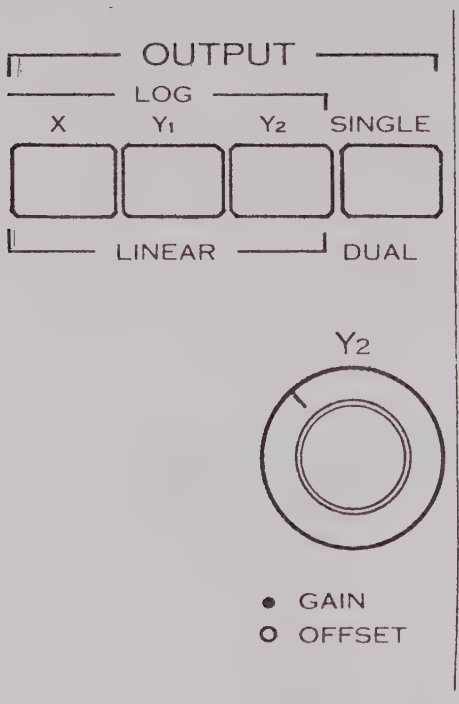


Figure 2-20. Output Group

2.2.20 Output Group

Refer to Figure 2-20. The output group controls the linear to logarithmic conversion of the X and Y-axis data to display. This group also selects single or dual Y-axis display. The Y2 co-axial controls provide independent offset and gain of Y2 data on the CRT and plotter outputs. In SINGLE output, the display of Y1 or Y2 data is controlled by the position of the toggle switch shown in Figure 2-15. The SINGLE/DUAL pushbutton is inoperative in System Functions 5, 6 and 15.

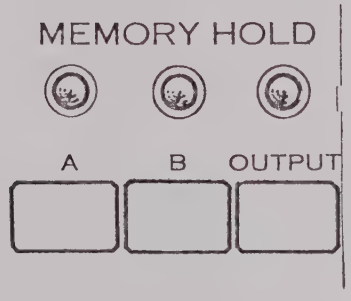


Figure 2-21. Memory Hold Group

2.2.21 Memory Hold Group

Refer to Figure 2-21. The memory hold group controls write inhibit of the input memories and the output memory. When the MEMORY HOLD indicators are on, the normal writing function in memory is inhibited.

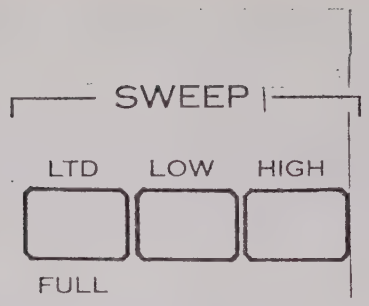


Figure 2-22. Sweep Group

2.2.22 Sweep Group

Refer to Figure 2-22. With the LTD/FULL push button out, a full sweep of data in output memory is displayed. When the LTD/FULL push button is in, the sweep is limited to the high and low limits that have been set at the cursor position with the HIGH and LOW limit push buttons. In system functions 5, 6 and 15, the LOW sweep limit is inoperative.

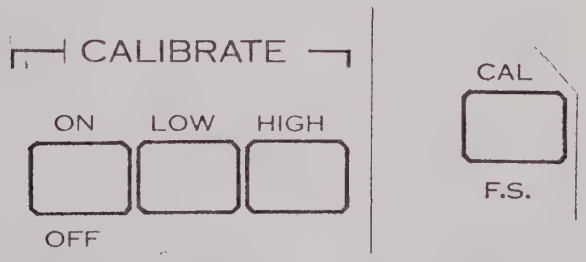


Figure 2-23. Calibrate Group

2.2.23 Calibrate Group

Refer to Figure 2-23. The calibrate group controls the selection of calibration levels for calibrating the oscilloscope and plotter displays. See Appendix A for combinations.

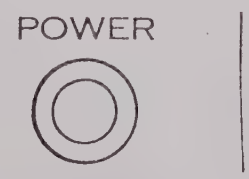


Figure 2-24. POWER Switch/Indicator

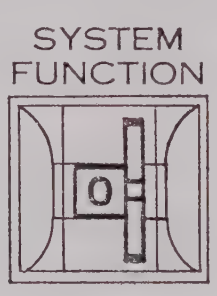
2.2.24 POWER Switch/Indicator

Refer to Figure 2-24. The POWER switch/indicator is used to turn the DSP on and off. An identical switch/indicator is located on Unit 1 for power to that unit.

Figure 2-25. CRT Output Group

2.2.25 CRT Output Group

Refer to Figure 2-25. The CRT output group provides X and Y-axis outputs for the oscilloscope display. These connectors parallel corresponding rear panel connectors.



0 LOAD A IN A, B
1 COPY B TO A
2 A (1024) } FWD
3 A (2048) } TRANSFORM
4 DUAL A, B } FWD TRANSFORM
5 CROSS SPECTRUM
6 TRANSFER FUNCTION B/A
7 INPUT } INV
8 OUTPUT } INV TRANSFORM
9 AUTO CORRELATION
10 CROSS CORRELATION
11 CONVOLUTION
12 SIGNAL AVERAGE
13 SIG AVG/FCTN (2)
14 PROB DENSITY HISTOGRAM
15 PROB DISTRIBUTION

Figure 2-26. SYSTEM FUNCTION Switch

2.2.26 SYSTEM FUNCTION Switch

Refer to Figure 2-26. The SYSTEM FUNCTION thumbwheel switch selects the microprograms that execute system functions 0 through 15, listed below the switch and briefly described in the following paragraphs. (See Volume II, Operation, for a detailed description of each function.)

2.2.26.0 System Function 0 (LOAD A IN A, B)

System Function 0 is usually used with the transient capture mode. In this function, both input memories are loaded with input data from channel A. If an operator subsequently edits the data in input memory A and wishes to try out a number of different ideas, the original transient can always be recovered by executing System Function 1.

2.2.26.1 System Function 1 (COPY B TO A)

System Function 1 is used in conjunction with System Function 0. In this function, the contents of input memory B are copied into input memory A, in SINGLE execute mode.

2.2.26.2 System Function 2 (A(1024) FWD TRANSFORM)

System Function 2 performs a forward Fourier transform on 1024 words of data in input memory A. The ADC writes continuously into input memory, unless the MEMORY HOLD light is on. When an execute pulse occurs, 1024 data words in time ordered sequence are transferred at high speed from input memory to processor memory. During this transfer, the input data is multiplied by the selected weighting function. A single length transform is then computed together with the coordinate conversion selected by the display controls and the result is written into output memory. System Function 2 generates 512 frequency domain coefficients in either rectangular or polar coordinates.

2.2.26.3 System Function 3 (A(2048) FWD TRANSFORM)

In System Function 3, digitized input data from channel A is loaded alternately in input memory A and input memory B. When an execute pulse occurs, 1024 data words in input memory A are transferred to processor memory real and 1024 data words in input memory B are transferred to processor memory imaginary. Input data is multiplied by the selected weighting function during this transfer. A double length forward transform is then computed together with the coordinate conversion selected by the display controls and the result stored in output memory. System Function 3 generates 1024 frequency domain coefficients in either rectangular or polar coordinates.

2.2.26.4 System Function 4 (DUAL A, B FWD TRANSFORM)

In System Function 4, digitized input data from channel A is continuously loaded into input memory A, and digitized input data from channel B is continuously loaded into input memory B. When an execute pulse occurs, 1024 data words from input memory A are transferred to processor memory real and 1024 data words from input memory B are transferred to processor memory imaginary. During this transfer, the input data is multiplied by the selected weighting function. A complex forward Fourier transform is then computed and the resulting frequency domain coefficients for S_x and S_y are separated. A coordinate conversion is then computed as selected by the display controls and the result written into output memory. System Function 4 generates 512 frequency domain coefficients in either rectangular or polar coordinates for each input data channel.

2.2.26.5 System Function 5 (CROSS SPECTRUM)

The first part of the cross spectrum computation in System Function 5 is the same as System Function 4 to the point where S_x and S_y are separated. The cross spectrum is then computed and stored or averaged in output memory in rectangular coordinates. A coordinate conversion is then computed as selected by the display controls and the result output for CRT display and plotting. In System Function 5, data in output memory, as floating point numbers, is always in rectangular coordinates. Loading of input memory B with respect to input memory A can be delayed by k half-memory periods, where k = 0, 1 . . . . , 15 as set on the k-switch.

2.2.26.6 System Function 6 (TRANSFER FUNCTION B/A)

The first part of the transfer function computation in System Function 6 is the same as System Function 5. In addition, the power spectrum of data from channel A is stored or averaged in a second output memory. With the COP/T.F. push button out, the transfer function is then computed together with a coordinate conversion as selected by the display controls and the result output for CRT display and plotting. If the COP/T.F. push button is in, the coherent output power is computed instead of the transfer function.

2.2.26.7 System Function 7 (INPUT INV TRANSFORM)

In System Function 7, input data in the frequency domain is inverse transformed into the time domain, using SINGLE EXECUTE mode. The only practical way to get frequency domain data into input memory is by using EDIT MODIFY and the CURSOR. Input data for System Function 7 can also be supplied by digital data transfer from the memory of an associated minicomputer. Either or both input memories may be used and the rules for even or odd symmetry of the data should be observed.The settings of the display controls to output the results from either processor memory real or imaginary are shown in Appendix A.

2.2.26.8 System Function 8 (OUTPUT INV TRANSFORM)

Input data for System Function 8 must be stored in output memory in rectangular coordinates. This can be done by executing System Functions 2, 4 or 5 with the display controls set for RECT conversion. The input data can be a single ensemble or the average of a number of ensembles. System Function 8 should be executed in SINGLE EXECUTE mode. When the execute pulse occurs, data from output memory is loaded into processor memory with Hermitian symmetry so that all data will transform into the real time domain. The settings of the display controls to output the results from either processor memory real or imaginary are shown in Appendix A.

2.2.26.9 System Function 9 (AUTO CORRELATION)

System Function 9 is obtained by computing the inverse transform of the power spectrum of data from channel A. Input from channel A is simultaneously loaded into both input memories A and B. The rest of the process is exactly the same as System Function 10.

2.2.26.10 System Function 10 (CROSS CORRELATION)

System Function 10 is obtained by computing the inverse transform of the cross power spectrum of data from channels A and B. Input data is loaded into input memory the same as in System Function 4 except that only half of each memory is loaded with data while the other half is effectively zeroed. This is done to avoid the problem of circular correlation. When an execute pulse occurs, the data is transformed to the frequency domain and stored in output memory the same as in System Function 5. If averaging is selected, only the LIN averaging mode may be used. When averaging is complete, the data is inverse transformed as in System Function 8 and the results written back into output memory for CRT display and plotting. Bowtie correction can be selected by pressing in DISPLAY push buttons 1 and 4. Any other combination will not provide bowtie correction.

2.2.26.11 System Function 11 (CONVOLUTION)

System Function 11 is primarily a time domain filtering operation. The data in input memory B should be the impulse response of the desired filtering function. As a consequence, System Function 11 is designed to operate primarily on digital data from a minicomputer. The operation of System Function 11 is similar to System Function 10 except that in the frequency domain, the data stored or averaged in output memory is the convolution spectrum instead of the cross power spectrum.

2.2.26.12 System Function 12 (SIGNAL AVERAGE)

In System Function 12, time domain data from input memory A is averaged in output memory using controls in the AVERAGING group and the TRANSFORMS PER MEMORY PERIOD 1 push button. Since time domain data is bipolar, only the coherent data in successive ensembles will average up, while the non-coherent data components will average down. For best results, the external frame sync pulse and the ADC clocking pulses are derived from an SD134A Tracking Ratio Tuner. Data can be continuously displayed on the CRT while signal averaging is in process. A forward transform of time domain data from System Function 12 can be implemented by selecting LIN averaging, then executing System Function 13 in SINGLE EXECUTE mode. Do not press AVG RESET during this sequence.

2.2.26.13 System Function 13(SIG AVG/FCTN (2))

System Function 13 is a combination of System Function 12 followed by a System Function 2 transform of the time domain data in output memory. System Function 13 works only in the LIN averaging mode. Coordinate conversion after the forward transform is selected with the display controls.

2.2.26.14 System Function 14 (PROB DENSITY HISTOGRAM)

System Function 14 computes the probability density histogram (PDH) of data in input memory A, which describes the probability that the data value will be within a given amplitude window (class interval) at any X-axis address (time). When an execute pulse occurs, the 7 MSBs of each input memory word plus three zero-value LSBs are used as a 10-bit address to output memory, where a 1 is added to denote an occurrence in the class interval. There are 128 class intervals in the histogram for a full scale input signal. Each step in the histogram represents a separate class interval. The amplitude of the step represents the number of occurrences of data in that class interval. The number of occurrences in the class interval which contains zero amplitude input data is displayed in the center of the X-axis on the CRT display. Data from class intervals of negative input data are displayed to the left of center and data from class intervals of positive input data are displayed to the right of center. In AVERAGING mode, only LIN averaging with TRANSFORMS PER MEMORY PERIOD 1 push button in may be used. The maximum n-switch setting is data dependent. If output memory overflows at any address location, the n-switch setting is too high.

2.2.26.15 System Function 15 (PROB DISTRIBUTION)

System Function 15 computes the integral of the probability density histogram computed in System Function 14, as PDH data is read out of output memory. System Function 14 must be executed and PDH data stored in output memory before System Function 15 will generate the probability distribution.

2.3 REAR PANEL CONNECTORS

The following paragraphs describe the functions of the rear panel connectors on Unit 1 and Unit 2. Each is illustrated to facilitate the description.

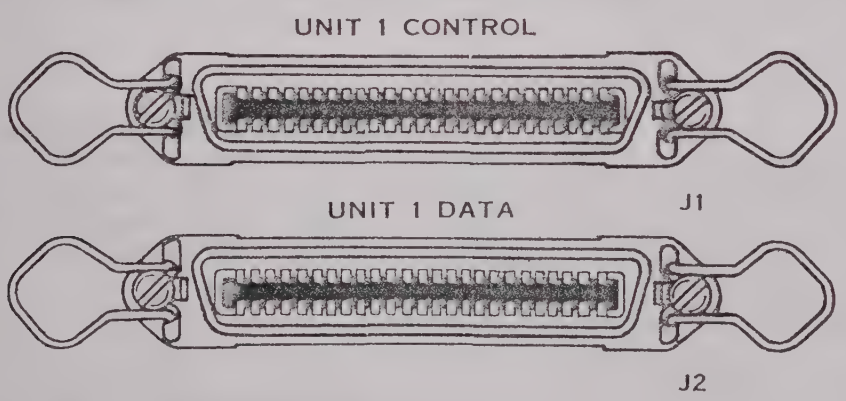


Figure 2-27. Multipin Connectors, Unit 1

2.3.1 Multipin Connectors, Unit 1

Refer to Figure 2-27. The interconnecting cables between Unit 1 and Unit 2 plug into J1 and J2. Following are the pin assignments for the UNIT 1 CONTROL and UNIT 1 DATA multipin connectors.

NOTE

All assignments listed are the signal name at the connector. Signals with a bar over the name are negative true logic. All others are positive true logic.

PIN	Assignment	Pin	Assignment
1	A/D CLOCK*	26	$\overline{\text{FREQ X10}}$
2	SAMPLE PULSE B	27	$\overline{\text{FREQ X10K}}$
3	SAMPLE PULSE A	28	$\overline{\text{FREQ X1K}}$
4	GATED DIRECT A	29	GATED DIRECT B
5	ATTEN A-2	30	TRIG LEVEL SEL B
6	ATTEN A-1	31	$\overline{\text{STORE } f_c}$
7	ATTEN A-8	32	SEL ALIAS FLTR B
8	ATTEN A-4	33	$\overline{\text{SINGLE EXEC}}$
9	ATTEN A-10	34	$\overline{\text{CAL ON}}$
10	SEL ALIAS FLTR A	35	$\overline{\text{TRANS CAP SW}}$
11	ATTEN A-40	36	$\overline{\text{ARM}}$
12	ATTEN A-20	37	ENABLE CURSOR Y CH B
13	ATTEN B-2	38	CURSOR RESET
14	ATTEN B-1	39	$\overline{\text{F.S. CAL}}$
15	ATTEN B-8	40	$\overline{\text{CAL SIG}}$
16	ATTEN B-4	41	CURSOR Y AXIS CTL
17	ATTEN B-10	42	SPARE
18	ENABLE CURSOR Y CH A	43	SPARE
19	ATTEN B-40	44	SPARE
20	ATTEN B-20	45	SPARE
21	$\overline{\text{FREQ -2}}$	46	SPARE
22	$\overline{\text{FREQ -1}}$	47	GND
23	$\overline{\text{FREQ -8}}$	48	GND
24	$\overline{\text{FREQ -4}}$	49	GND
25	$\overline{\text{FREQ X100}}$	50	GND

*As selected

UNIT 1 DATA J2

Pin	Assignment	Pin	Assignment
1	DATA MEM A BIT 1	26	DATA MEM B BIT 11
2	DATA MEM A BIT 10	27	TRANS CAP TRIG LEVEL A
3	DATA MEM A BIT 3	28	$\overline{\text{STORED FREQ X1}}$
4	DATA MEM B SIGN BIT	29	SIGNAL LEVEL A A
5	DATA MEM A BIT 5	30	$\overline{\text{STORED FREQ X4}}$
6	DATA MEM B BIT 2	31	SIGNAL LEVEL B A
7	DATA MEM A BIT 7	32	$\overline{\text{STORED FREQ 10}}$
8	DATA MEM B BIT 4	33	SPARE
9	DATA MEM A BIT 9	34	$\overline{\text{STORED FREQ X1K}}$
10	DATA MEM B BIT 6	35	SPARE
11	DATA MEM A BIT 11	36	$\overline{\text{OVERLOAD A}}$
12	DATA MEM B BIT 8	37	SPARE
13	DATA MEM A SIGN BIT	38	A/D TRIG
14	DATA MEM B BIT 10	39	SPARE
15	DATA MEM A BIT 2	40	$\overline{\text{STORED FREQ X2}}$
16	DATA MEM B BIT 1	41	SPARE
17	DATA MEM B BIT 4	42	$\overline{\text{STORED FREQ X8}}$
18	DATA MEM B BIT 3	43	$\overline{\text{OVERLOAD B}}$
19	DATA MEM A BIT 6	44	$\overline{\text{STORED FREQ X100}}$
20	DATA MEM B BIT 5	45	SPARE
21	DATA MEM A BIT 8	46	$\overline{\text{STORED FREQ X10K}}$
22	DATA MEM B BIT 7	47	GND
23	GND	48	GND
24	DATA MEM B BIT 9	49	GND
25	GND	50	GND

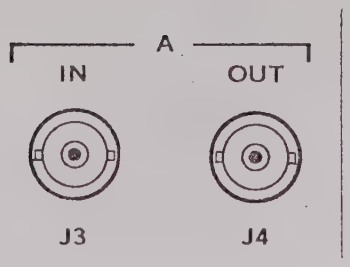


Figure 2-28. A IN/OUT Group, Unit 1

2.3.2 A IN/OUT Group, Unit 1

Refer to Figure 2-28. The IN connector accepts channel A input data in parallel with the corresponding front-panel connector. Signal conditioned analog data is available from the Channel A OUT connector.

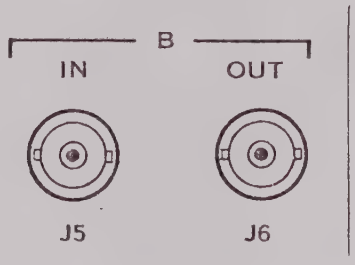


Figure 2-29. B IN/OUT GROUP, Unit 1

2.3.3 B IN/OUT Group, Unit 1

Refer to Figure 2-29. The IN connector accepts channel B input data in parallel with the corresponding front-panel connector. Signal conditioned analog data is available from the channel B OUT connector.

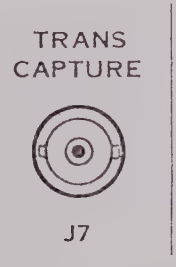


Figure 2-30. TRANS CAPTURE Connector, Unit 1

2.3.4 TRANS CAPTURE Connector, Unit 1

Refer to Figure 2-30. The TRANS CAPTURE connector accepts an external analog or digital signal for transient capture triggering. The triggering threshold is determined by the setting of the TRIGGER LEVEL control on the front panel of Unit 2.

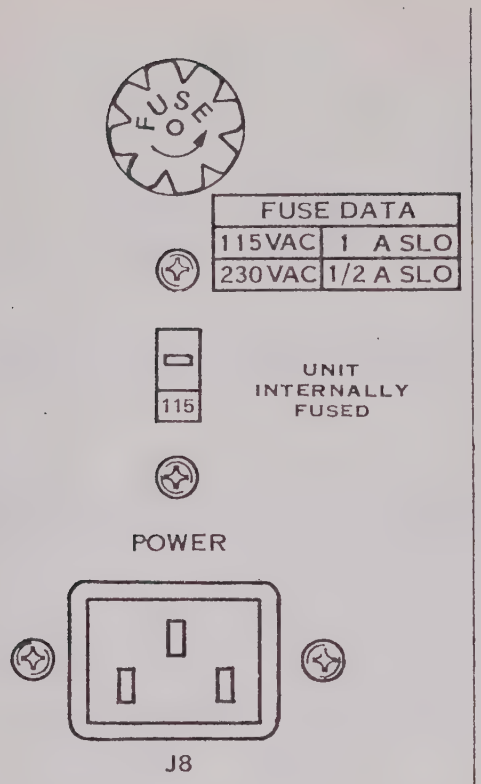


Figure 2-31. Power Input Group, Unit 1

2.3.5 Power Input Group, Unit 1

Refer to Figure 2-31. The power input group consists of a fuse holder, an AC line voltage switch for selecting 115 Vac or 230 Vac operation and a connector to accept input AC power for Unit 1.

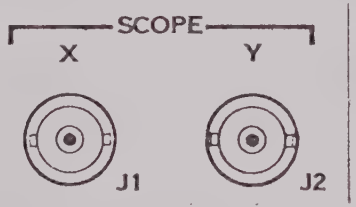


Figure 2-32. SCOPE Group, Unit 2

2.3.6 SCOPE Group, Unit 2

Refer to Figure 2-32. The SCOPE group provides the X and Y-axis outputs for oscilloscope display.

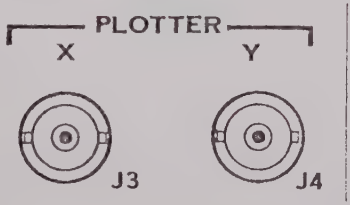


Figure 2-33. PLOTTER Group, Unit 2

2.3.7 PLOTTER Group, Unit 2

Refer to Figure 2-33. The PLOTTER group provides the X and Y-axis outputs for plotting.

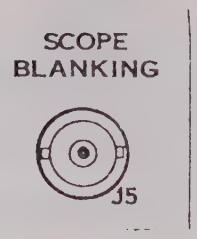


Figure 2-34. SCOPE BLANKING Connector, Unit 2

2.3.8 SCOPE BLANKING Connector, Unit 2

Refer to Figure 2-34. The SCOPE BLANKING connector provides oscilloscope retrace blanking pulses.

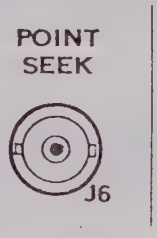


Figure 2-35. POINT SEEK Connector, Unit 2

2.3.9 POINT SEEK Connector, Unit 2

Refer to Figure 2-35. The POINT SEEK pulse from this connector initiates plotting a data point on the point plotter.

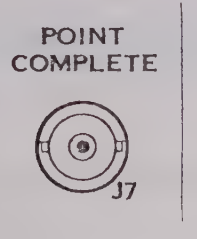


Figure 2-36. POINT COMPLETE connector, Unit 2

2.3.10 POINT COMPLETE Connector, Unit 2

Refer to Figure 2-36. The POINT COMPLETE connector accepts a pulse from the point plotter which indicates that the last point has been plotted and the plotter is ready for the next data point.

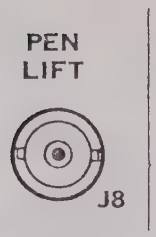


Figure 2-37. PEN LIFT Connector, Unit 2

2.3.11 PEN LIFT Connector, Unit 2

Refer to Figure 2-37. The PEN LIFT connector provides a contact closure to put the pen down on an X-Y plotter when the PLOT light is on.

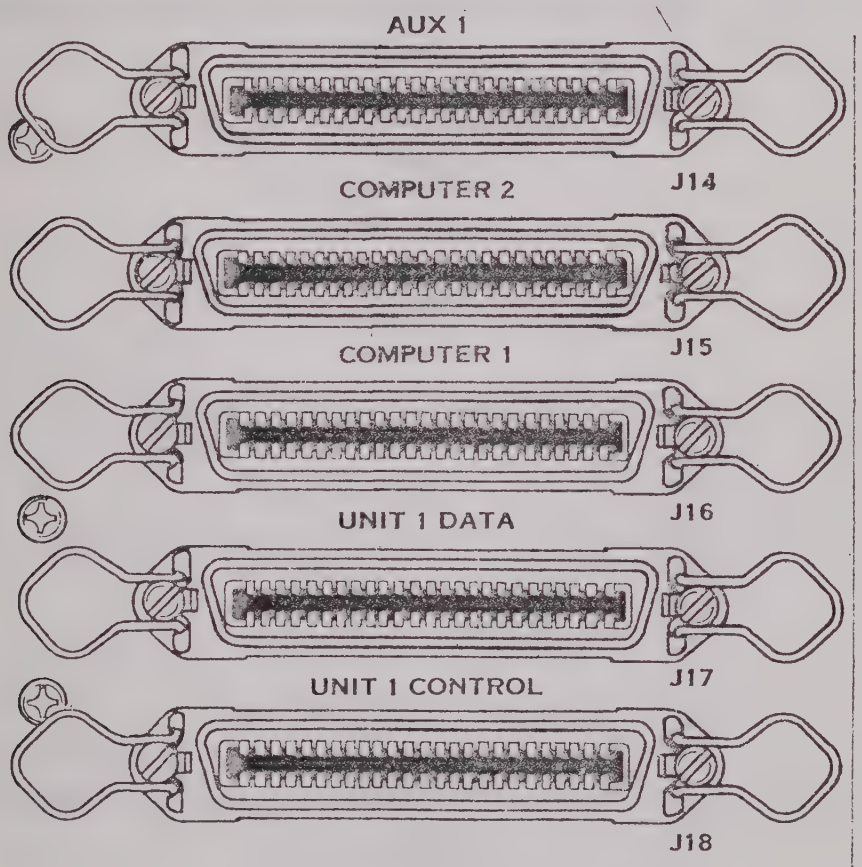


Figure 2-38. Multipin Connectors, Unit 2

2.3.12 Multipin Connectors, Unit 2

Refer to Figure 2-38. The interconnecting cables between Unit 1 and Unit 2 plug into J17 and J18. COMPUTER 1 is used for remote sense of the front panel controls and for remote control of the DSP. COMPUTER 2 is used for digital I/O to a minicomputer. AUX 1 provides inputs for pulse and logic level control of a number of auxiliary operations, over and above those provided on the front panel. Some of the capabilities controlled via AUX 1 are translation, signature ratio, external control of sampling, etc. Following are the pin assignments for the AUX 1, COMPUTER 1 and COMPUTER 2 multipin connectors. (See paragraph 2.3.1 for UNIT 1 DATA and UNIT 1 CONTROL pin assignments.)

NOTE

All assignments listed are the signal name at the connector. Signals with a bar over the name are negative true logic. All others are positive true logic.

AUX 1 J14

Pin	Assignment	Pin	Assignment
1	SEL OTP CLK	26	SPARE
2	$\overline{\text{EXT SAMPLE FREQ CTL}}$	27	SPARE
3	EXT SAMPLE FREQ	28	SPARE
4	BUFFERED SAMPLE PLS	29	SPARE
5	SPARE	30	SPARE
6	EXECUTE PULSE OTP	31	SPARE
7	SPARE	32	SPARE
8	SPARE	33	SPARE
9	FRAME SYNC	34	SPARE
10	WORD SYNC	35	SPARE
11	$\overline{\text{MEM HOLD A EXT}}$	36	SPARE
12	$\overline{\text{MEM HOLD B EXT}}$	37	SPARE
13	CURSOR	38	SPARE
14	INTENSITY/BLANKING	39	SPARE
15	SYNC IN	40	SPARE
16	$\overline{\text{MEM HOLD OTP EXT}}$	41	SPARE
17	SWEEP	42	SPARE
18	SWEEP COMPLETE	43	SPARE
19	SEEN SIGNAL	44	SPARE
20	COMPLETE PLOT	45	SPARE
21	$\overline{\text{ENBL SIG RATIO}}$	46	SPARE
22	$\overline{\text{TRANSLATE}}$	47	SPARE
23	SPARE	48	SPARE
24	SPARE	49	B GND
25	SPARE	50	B GND

Pin	Assignment	Pin	Assignment
1	DIG DATA IN A15	26	DIG DATA IN A14
2	DIG DATA IN A13	27	DIG DATA IN A12
3	DIG DATA IN A11	28	DIG DATA IN A10
4	WRITE COMPLETE	29	B GND
5	B GND	30	B GND
6	B GND	31	SPARE
7	$\overline{\text{DIG A}}$	32	$\overline{\text{TEST MODE}}$
8	$\overline{\text{DIG B}}$	33	FRAME SYNC
9	DIG OUTPUT FLAG	34	CURSOR
10	DIG START	35	SINGLE SWEEP OUT
11	INITIATE WRITE SEQ	36	REQ A
12	DATA TRANSMIT	37	NEW DATA READY # 2
13	DIG OUT A1	38	DIG OUT A0
14	DIG OUT A3	39	DIG OUT A2
15	DIG OUT A5	40	DIG OUT A4
16	DIG OUT A7	41	DIG OUT A6
17	DIG OUT A9	42	DIG OUT A8
18	DIG OUT A11	43	DIG OUT A10
19	DIG OUT A13	44	DIG OUT A12
20	DIG OUT A15	45	DIG OUT A14
21	DIG DATA IN A9	46	DIG DATA IN A8
22	DIG DATA IN A7	47	DIG DATA IN A6
23	DIG DATA IN A5	48	DIG DATA IN A4
24	DIG DATA IN A3	49	DIG DATA IN A2
25	DIG DATA IN A1	50	DIG DATA IN A0

COMPUTER 2 J15

Pin	Assignment	Pin	Assignment
1	$\overline{\text{SENSE BIT 12}}$	26	$\overline{\text{SENSE BIT 13}}$
2	$\overline{\text{SENSE BIT 14}}$	27	$\overline{\text{SENSE BIT 15}}$
3	$\overline{\text{SENSE BIT 8}}$	28	$\overline{\text{SENSE BIT 9}}$
4	$\overline{\text{SENSE BIT 10}}$	29	$\overline{\text{SENSE BIT 11}}$
5	$\overline{\text{SENSE BIT 4}}$	30	$\overline{\text{SENSE BIT 5}}$
6	$\overline{\text{SENSE BIT 6}}$	31	$\overline{\text{SENSE BIT 7}}$
7	$\overline{\text{SENSE BIT 0}}$	32	$\overline{\text{SENSE BIT 1}}$
8	$\overline{\text{SENSE BIT 2}}$	33	$\overline{\text{SENSE BIT 3}}$
9	B GND	34	B GND
10	B GND	35	B GND
11	SPARE	36	SPARE
12	SPARE	37	READ COMPLETE #1
13	SPARE	38	SPARE
14	BUFF PROG COMP.	39	SPARE
15	AVG COMP.	40	REMOTE
16	REMOTE CTL IN A0	41	NEW DATA READY
17	REMOTE CTL IN A2	42	REMOTE CTL CSR BIT
18	REMOTE CTL IN A4	43	REMOTE CTL CSR BIT
19	REMOTE CTL IN A6	44	REMOTE CTL CSR BIT
20	REMOTE CTL IN A10	45	REMOTE CTL IN A1
21	REMOTE CTL IN A8	46	REMOTE CTL IN A3
22	REMOTE CTL IN A14	47	REMOTE CTL IN A7
23	REMOTE CTL IN A12	48	REMOTE CTL IN A5
24	REMOTE CTL IN A9	49	REMOTE CTL IN A11
25	REMOTE CTL IN A13	50	REMOTE CTL IN A15

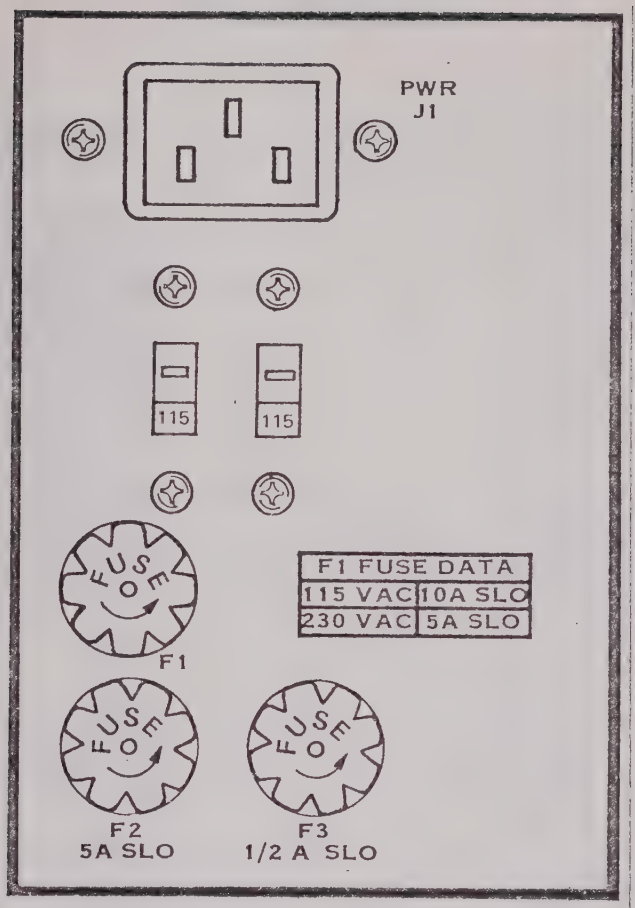


Figure 2-39. Power Input Group, Unit 2

2.3.13 Power Input Group, Unit 2

Refer to Figure 2-39. The power input group consists of three fuse holders, two AC line voltage switches for selecting 115 Vac or 230 Vac operation and a connector to accept input AC power for Unit 2.

APPENDIX A
SD360 CONTROLS AND INDICATORS

A1.1 INTRODUCTION

This Appendix contains complete descriptions of each control and indicator found on the SD360 and of the functions performed or affected by each. It is intended to supplement and amplify the operation descriptions contained in Section II of this Instruction Manual and to enable the user to increase his familiarity with the SD360 controls and indicators.

A1.2 FORMAT

The information in this Appendix is tabulated for maximum convenience. The order in which controls and indicators are listed parallels the order in which the control groups are discussed in Section II of this Instruction Manual. Figure A-1 illustrates the SD360 Unit 2 front panel and is placed at the rear of the tabulated pages describing the front panel controls and indicators. It is arranged so as to fold out and be continuously visible for reference as the tabular material is studied. Figures A-2 and A-3 are similarly placed and arranged with regard to the tabular material describing the rear panel connectors of Unit 1 and Unit 2.

A1.3 FRONT PANEL CONTROLS AND INDICATORS

CONTROL*	CONDITION	DESCRIPTION
		A1.3.1 Signal Level Group
SIGNAL LEVEL A (Meter)	Indicating	Indicates peak signal amplitude of input signal A at the input to the ADC.
OVERLOAD (LED)	ON	Indicates overload condition on channel A.
SIGNAL LEVEL B (METER)	Indicating	Indicates peak signal amplitude of input signal B at the input to the ADC.
OVERLOAD (LED)	ON	Indicates overload condition on channel B.
ATTEN A (Thumbwheel switch)	As Req.	Attenuates input signal A over the range 0 to –69 dB in 1 dB steps.
ATTEN B (Thumbwheel switch)	As Req.	Attenuates input signal B over the range 0 to –69 dB in 1 dB steps.
		A1.3.2 REMOTE Indicator
REMOTE (LED)	ON	Indicates control of most front panel functions is remote.
	OFF	Indicates front panel functions are under local control.
		A1.3.3 Edit Input Group
A	IN	Enables edit function for input memory A.
B	IN	Enables edit function for input memory B.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
A and B	IN	Enables edit function for input memories A and B simultaneously with A as master, B as slave.
MODIFY	IN	Enables manual modification of data in input memory via 2-axis CURSOR control.
ZERO	IN	Enables manual zeroing of data in input memory via 2-axis CURSOR control.
ROTATE	IN	Enables rotation of data in input memory via 2-axis CURSOR control.
ON/OFF	IN	Enables selected edit functions.
	OUT	Disables selected input functions.
		A1.3.4 Cursor Group
ON/OFF	IN	Enables cursor functions.
	OUT	Disables cursor functions.
RESET	Pressed	a. Resets cursor to X-axis relative address zero.
		b. Sets modify integrator output to zero.
CURSOR ("Joystick")	Right	Controls the rate at which pulses are counted up in the cursor address counter when CURSOR ON selected.
	Left	Controls the rate at which pulses are counted down in the cursor address counter when CURSOR ON selected.
	Up or Down	Varies the input to an analog integrator the output of which is connected to the selected ADC for channel A, channel B or both A and B, controlling the rate of change of data value when CURSOR ON and EDIT INPUT MODIFY selected.
	Up	Gates clock pulses into an up/down counter used for vertical offset of the oscilloscope and X-Y plotter displays, making the display appear to move up at a rate increasing with displacement from center when CURSOR ON, LOG Y1 or LOG Y2 selected.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
	Down	Gates clock pulses into an up/down counter used for vertical offset of the oscilloscope and X-Y plotter displays, making the display appear to move down at a rate increasing with displacement from center when CURSOR ON, LOG Y1 or LOG Y2 selected.
		A1.3.5 Analysis Range Group
		NOTE
f-switch X10 X100 X1000 X10000	1-15	The analysis range selected (FREQ/Hz) is the product of the f-switch setting (1-15) and one of the four decade multiplier push buttons (X10, X100, 1000 or 10000). The TIME (SEC) notation under the multiplier push buttons gives the ratio for computing the time in seconds (memory period) to load 1024 data samples into input memory.
ALIASING FILTERS STORE f_c	IN	Holds aliasing filter cutoff frequency for a given FREQ/TIME selection so that an independent FREQ/TIME selection can be made. The aliasing filter cutoff frequency remains that of the earlier selection, when the STORE f_c push button was pressed in.
ALIASING FILTERS IN/OUT	IN	Analog input data goes through the anti-aliasing filter.
	OUT	Analog input data bypasses the anti-aliasing filter.
		A1.3.6 Averaging Group
AVERAGING (n-switch)	0-12	Selects the number of ensembles (N) to be averaged in LIN AVG. $N = 2^n$. (Selects the averaging "time constant" in EXP. AVG.)
AVG	Pressed	Turns AVG LED on or off.
AVG (LED)	ON	Indicates that the selected averaging process is occurring.
	OFF	Indicates that the selected averaging process is completed or stopped.
LIN	IN	Selects linear averaging process.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
EXP	IN	Selects exponential averaging process.
EXP (LED)	ON	Indicates that LIN averaging is complete.
	Flashing	Indicates that exponential averaging is in process.
PEAK	IN	Selects peak hold process.
		Stores the largest value from a sequence of ensembles for each address location.
+1	Pressed	Adds one ensemble to a selected averaging process turning the AVG LED on and then off.
RESET	Pressed	Resets the ensemble counter to zero.
		A1.3.7 WTG Push Button
WTG	IN	Data forward transformed with Kaiser-Bessel weighting when applicable.
	OUT	Data forward transformed with rectangular weighting.
		A1.3.8 RUN Indicator
RUN (LED)	ON	The RUN light is ON when a microprogram sequence is being executed; otherwise it is OFF.
		A1.3.9 Transient Capture Group
TRIGGER LEVEL (A) (Knob)	IN	Adjusts the triggering level on data from channel A for internal triggering of transient capture. It also adjusts the triggering level from external data when the INT/EXT push button is out.
	OUT	Digitizes the trigger level and loads it into input memory B so that the trigger level can be superimposed on the display oscilloscope with data from input memory A in dual display mode.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
INT/EXT	IN	Selects transient capture trigger pulse generated when the signal in channel A exceeds the absolute magnitude of the trigger level.
	OUT	Selects TRANSIENT CAPTURE BNC connector on the rear of Unit 1 as the source of the signal to trigger transient capture.
ARM	Pressed	Turns the ARM (LED) on or off.
ARM (LED)	ON	Indicates that transient capture mode is armed.
	OFF	Indicates that transient capture mode is inactive.
		A1.3.10 Transforms Per Memory Period Group
SINGLE	IN	One system function is executed each time the EXECUTE push button is pressed. Also required for transient capture mode.
1	IN	Initiates processing of the selected function each time 1024 new data words are written into input memory (2048 words for System Function 3).
2	IN	Initiates processing of the selected function each time 512 new data words are written into input memory (1024 words for System Function 3).
4	IN	Initiates processing of the selected function each time 256 new data words are written into input memory (512 words for System Function 3).
MAX	IN	Initiates processing of the selected function at the maximum possible rate.
		A1.3.11 Delay Channel B Group
INT/EXT	IN	Selects internal trigger pulse to delay loading of input memory B with respect to input memory A in System Functions 5 or 10.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
	OUT	Selects external or manual trigger pulse to delay loading of input memory B with respect to input memory A in System Functions 5 or 10.
k-switch	0-15	Selects number of half memory periods (0-15) to delay the loading of input memory B with respect to input memory A in System Functions 5 or 10.
		A1.3.12 Signal Input Group (Unit 1)
A (Connector)		Accepts the channel A input data signal in parallel with rear panel connector J3.
DC/AC COUPLING (Rocker Switch)	DC	Input signals to channels A and B are direct coupled.
	AC	Input signals to channel A and B are capacitively coupled through a 0.47 second time constant. (Down 3 dB at 0.34 Hz.)
B (Connector)		Accepts the channel B input data signal in parallel with rear panel connector J5.
		A1.3.13 EXECUTE Push Button
EXECUTE	Pressed	a. Loads microprogram for selected system function. b. Generates execute pulse in SINGLE execute mode. c. Generates a trigger pulse for transient capture or delay channel B.
		A1.3.14 SETUP ERROR Indicator
SETUP ERROR (LED)	ON	Indicates that the front panel switch configuration is incorrect.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
		A1.3.15 LED Display Control and Indicator Group
6-Decimal Digit Display (LED)	ON	Provides a numerical display of selected data.
Units Indicator (6-Lamp)	Hz ON	Indicates that the numerical value on the LED display is frequency information in Hertz.
	deg ON	Indicates that the numerical value on the LED display is phase information in degrees.
	lin ON	Indicates that the numerical value on the LED display is linear data.
	ms ON	Indicates that the numerical value on the LED display is time information in milliseconds.
	dB ON	Indicates that the numerical value on the LED display is amplitude information in dB.
	log ON	Indicates that the numerical value on the LED display is logarithmic information.
Y2/Y1/X (3-Position Toggle Switch)	Up	Selects display of Y2-axis data value at cursor address.
	Center	Selects display of Y1-axis data value at cursor address.
	Down	Selects display of X-axis data value at cursor address.
Set 0 dB	Pressed	Sets 0 dB reference in the LED display when OUTPUT LOG Y1 or Y2 selected.
	Pressed	Sets full scale as 0 dB reference in the LED display when CALIBRATE HIGH selected.
X ADRS	IN	Selects display of the cursor X-axis address when the toggle switch is in the X position.
f_c	Pressed	Selects display of the cutoff frequency f_c of the aliasing filters.
AVG COUNT	Pressed	Selects display of the value in the averaging ensemble counter.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
Δf	Pressed	Selects display of the frequency difference between adjacent locations in output memory for a frequency domain function.
$\Delta \tau$	Pressed	Selects display of the time difference between adjacent locations in output memory for a time domain function.
COP/T.F.	IN	Selects coherent output power (COP) when System Function 6 is selected.
	OUT	Selects transfer function when System Function 6 is selected.
		A1.3.16 Y-Scale Group
p-switch	0-5	a. Positions 2-5 select CRT log display range in dB. b. Position 1 displays relative offset of log data on the CRT. c. Position 0 resets the log data offset counter to zero.
q-switch	0-15	Controls Y-axis digital output gain (Gain = 2^q for q = 0, 1, . . . , 15) when OUTPUT LINEAR Y1 or Y2 push buttons are OUT. Provides adjustable base line clipping in 3 dB increments from –93 dB for q = 1 to –51 dB for q = 15, when OUTPUT LINEAR Y1 or Y2 push buttons are in. (No clipping for q = 0.)
		A1.3.17 Display Group
MEMORY INPUT/ OUTPUT	IN	Selects data in the input memories A and B for oscilloscope display and X-Y plotting.
	OUT	Selects data in the output memory for oscilloscope display and X-Y plotting.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
		NOTE The remaining push buttons in the Display Group are numbered 1 through 7 for convenience in describing the operations they control. The following operations are performed with the indicated push buttons in the System Function selected.
	(System Function)	
4	2	Transfers 512 real and 512 imaginary data words from channel A to output memory.
5	2	Transfers 512 magnitude and 512 phase data words from channel A to output memory.
6	2	Transfers 512 magnitude squared and 512 phase data words from channel A to output memory.
7	2	Same as 4 above, except CO/QUAD display.
1,4	3	Transfers 1024 data words from processor memory real to output memory.
2,4	3	Transfers 1024 data words from processor memory imaginary to output memory.
1,5	3	Transfers 1024 magnitude data words to output memory.
2,5	3	Transfers 1024 phase data words to output memory.
1,6	3	Transfers 1024 magnitude squared data words to output memory.
2,6	3	Transfers 1024 phase data words to output memory.
1,7	3	Not valid.
2,7	3	Not valid.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
	(System Function)	
3,4-7	3	Not valid.
1,4	3	Transfers 512 real data words computed from channel A to output memory Y1 and 512 imaginary data words computed from channel A to output memory Y2.
2,4	4	Transfers 512 real data words computed from channel B to output memory Y1 and 512 imaginary data words computed from channel B to output memory Y2.
3,4	4	Not valid.
1,5	4	Transfers 512 magnitude data words computed from channel A to output memory Y1 and 512 phase data words computed from channel A to output memory Y2.
2,5	4	Transfers 512 magnitude data words computed from channel B to output memory Y1 and 512 phase data words computed from channel B ot output memory Y2.
3,5	4	See Work Request sheet.
1,6	4	Transfers 512 magnitude^2 data words computed from channel A to output memory Y1 and 512 magnitude^2 data words computed from channel A to output memory Y2.
2,6	4	Transfers 512 magnitude squared data words computed from channel B to output memory Y1 and 512 phase data words computed from channel B to output memory Y2.
3,6	4	Transfers 512 magnitude squared data words computed from channel A to output memory Y1 and 512 magnitude squared data words computed from channel B to output memory Y2.
1,7	4	Same as 1,4 except CO/QUAD display.
2,7	4	Same as 2,4 except CO/QUAD display.

*All controls are pushbuttons unless otherwise indicated.

CONTROL*	CONDITION	DESCRIPTION
	(System Function)	
3,7	4	Not valid.
1,4	7	Transfers 1024 data words from processor memory real to output memory.
2,4	7	Transfers 1024 data words from processor memory imaginary to output memory.
1,4	8	Transfers 1024 data words from processor memory real to output memory.
2,4	8	Transfers 1024 data words from processor memory imaginary to output memory.
1,4	9,10	Transfers 1024 data words from processor memory real with bowtie correction.
2,3,4-6	9,10	Transfers 1024 data words from processor memory real without bowtie correction.
		A1.3.18 OUTPUT OVERLOAD Indicator
OUTPUT OVERLOAD (LED)	ON	Indicates that output data is greater than full scale.
		A1.3.19 Plotter Group
PLOT	Pressed	Turns the PLOT LED on or off.
PLOT (LED)	ON	Indicates that the selected plotting function is occurring.
	OFF	Indicates that the selected plotting function is completed or has been stopped.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
POINT	IN	Selects point plotting function when a H-P 7004B High Speed Point Plotting X-Y Recorder or equivalent is connected to the DSP.
STEP	IN	Selects step plotting function when an analog X-Y recorder is connected to the DSP.
VECTOR	IN	Selects vector plotting function when an analog X-Y recorder is connected to the DSP.
		A1.3.20 Output Group
X	IN	Selects log X-axis.
	OUT	Selects linear X-axis.
Y1	IN	Selects log Y1-axis.
	OUT	Selects linear Y1-axis.
Y2	IN	Selects log Y2-axis
	OUT	Selects linear Y2-axis.
SINGLE/DUAL	IN	Selects single Y1-axis oscilloscope/plotter output when the toggle switch is in X or Y1 position. Selects single Y2-axis oscilloscope/plotter output when the toggle switch is in Y2 position.
	OUT	Selects dual Y1 and Y2-axis oscilloscope/plotter output.
Y2 GAIN/OFFSET (Coaxial Knobs)	Outer knob turned.	Controls Y2-axis offset.
	Inner knob turned.	Controls Y2-axis gain.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
		A1.3.21 Memory Hold Group
A	Pressed	Turns MEMORY HOLD A indicator ON or OFF.
B	Pressed	Turns MEMORY HOLD B indicator ON or OFF.
OUTPUT	Pressed	Turns MEMORY HOLD OUTPUT indicator ON or OFF.
A (LED)	ON	Indicates that input memory A is in hold mode.
	OFF	Indicates that input memory A is released from hold mode.
B (LED)	ON	Indicates that input memory B is in hold mode.
	OFF	Indicates that memory B is released from hold mode.
OUTPUT (LED)	ON	Indicates that output memory is in hold mode.
	OFF	Indicates that the output memory is released from hold mode.
		A1.3.22 Sweep Group
LTD/FULL	IN	Limits the X-axis sweep from the selected low limit to the selected high limit. (High limit only on System Functions 5, 10, and 15.)
	OUT	Displays all the data in the selected memory.
LOW	Pressed	Sets the low sweep limit at the cursor address.
HIGH	Pressed	Sets the high sweep limit at the cursor address.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
		A1.3.23 Calibrate Group
CAL/F.S.	IN	Connects calibration square wave to input of attenuators when CALIBRATE is ON.
	OUT	Connects calibration square wave after the attenuators when CALIBRATE is ON.
ON/OFF	IN	a. Sets up the output digital-to-analog converters to provide CRT/Plotter calibration voltage levels when the CALIBRATE LOW or HIGH push buttons are in. b. Applies internal analog square wave as a calibration signal when the CALIBRATE LOW and HIGH push buttons are OUT.
	OUT	Restores normal data display functions.
LOW	IN	Selects the low calibration voltage levels: a. Linear zero when OUTPUT LINEAR X and SWEEP LTD/FULL push buttons are both out. b. Voltage related to low limit set when OUTPUT LINEAR X push button is in and SWEEP LTD/FULL push button is out. c. Voltage corresponding to –2 decades below full scale when OUTPUT LOG X push button is in and SWEEP LTD/FULL push button is out. d. Voltage related to the log of the low limit set when OUTPUT LOG X and SWEEP LTD/FULL and LOW push buttons are in. e. Linear zero when OUTPUT LINEAR Y1 push button is out and OUTPUT SINGLE push button is in.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
LOW	IN	f. Voltage related to Y-SCALE p-switch setting when OUTPUT LOG Y1 and OUTPUT SINGLE push buttons are both in, as follows: p — CALIB 2 — –20 dB 3 — –40 dB 4 — –80 dB 5 — –160 dB g. Linear zero when OUTPUT LINEAR Y1 or Y2 and SINGLE/DUAL push buttons are out and the toggle switch is in position Y1 or Y2. h. Composite of f. and g. above when OUTPUT Y1 or Y2 push buttons are in or out as necessary, OUTPUT DUAL push button is out and the toggle switch is in Y1 or Y2 positions. Possible combinations are: Y1 — Y2 LIN — LIN LOG — LIN LOG — LOG (Y1 LIN with Y2 LOG not valid)
HIGH	IN	Selects the high calibration voltage level: a. Voltage corresponding to output memory address 500 when System Function 2 is selected, OUTPUT LINEAR X and SWEEP LTD/FULL push buttons are both out. b. Voltage corresponding to output memory address 1000 when System Function 3 is selected, OUTPUT LINEAR X and SWEEP LTD/FULL push buttons are both out.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
HIGH	IN	c. Voltage related to the high limit set when OUTPUT LINEAR X push button is out and SWEEP LTD/FULL push button is in. d. Voltage which is the log equivalent of output memory address 500 when System Function 2 is selected, OUTPUT LOG X push button is in and SWEEP LTD/FULL push button is out. e. Voltage which is the log equivalent of output memory address 1000 when System Function 3 is selected, OUTPUT LOG X push button is in and SWEEP LTD/FULL push button is out. f. Voltage related to the log equivalent of the high limit set when OUTPUT LOG X and SWEEP LTD/FULL push buttons are in. g. Full scale calibration voltage when OUTPUT LINEAR Y1 push button is out and OUTPUT SINGLE push button is in. h. Full scale calibration voltage when OUTPUT LOG Y1 and OUTPUT SINGLE push buttons are both in. i. Full scale calibration voltage when OUTPUT LINEAR Y1 and Y2 and SINGLE/DUAL push buttons are out, the toggle switch is in the Y1 or Y2 positions and Y2 GAIN/OFFSET controls are used as necessary. j. Same as i. above when OUTPUT LOG Y1 or Y2 push buttons are in, OUTPUT DUAL push button is out, and the toggle switch is in Y1 or Y2 positions.
		A1.3.24 POWER Switch/Indicator (1 each located on Unit 1 and Unit 2)
POWER (Pushbutton/ Indicator)	IN	Turns on primary power to the DSP and turns the lamp ON.
	OUT	Turns off primary power to the DSP and turns the lamp OFF.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
		A1.3.25 CRT Output Group
X (BNC Connector)		Provides X-axis output for the oscilloscope display.
Y (BNC Connector)		Provides Y-axis output for the oscilloscope display.
		A1.3.26 SYSTEM FUNCTION Thumbwheel Switch
SYSTEM FUNCTION (Thumbwheel switch)	As Req.	Selects microprograms that control the DSP system functions numbered 0-15. NOTE See Section II for a description of the numbered system functions.

*All controls are pushbuttons unless otherwise indicated

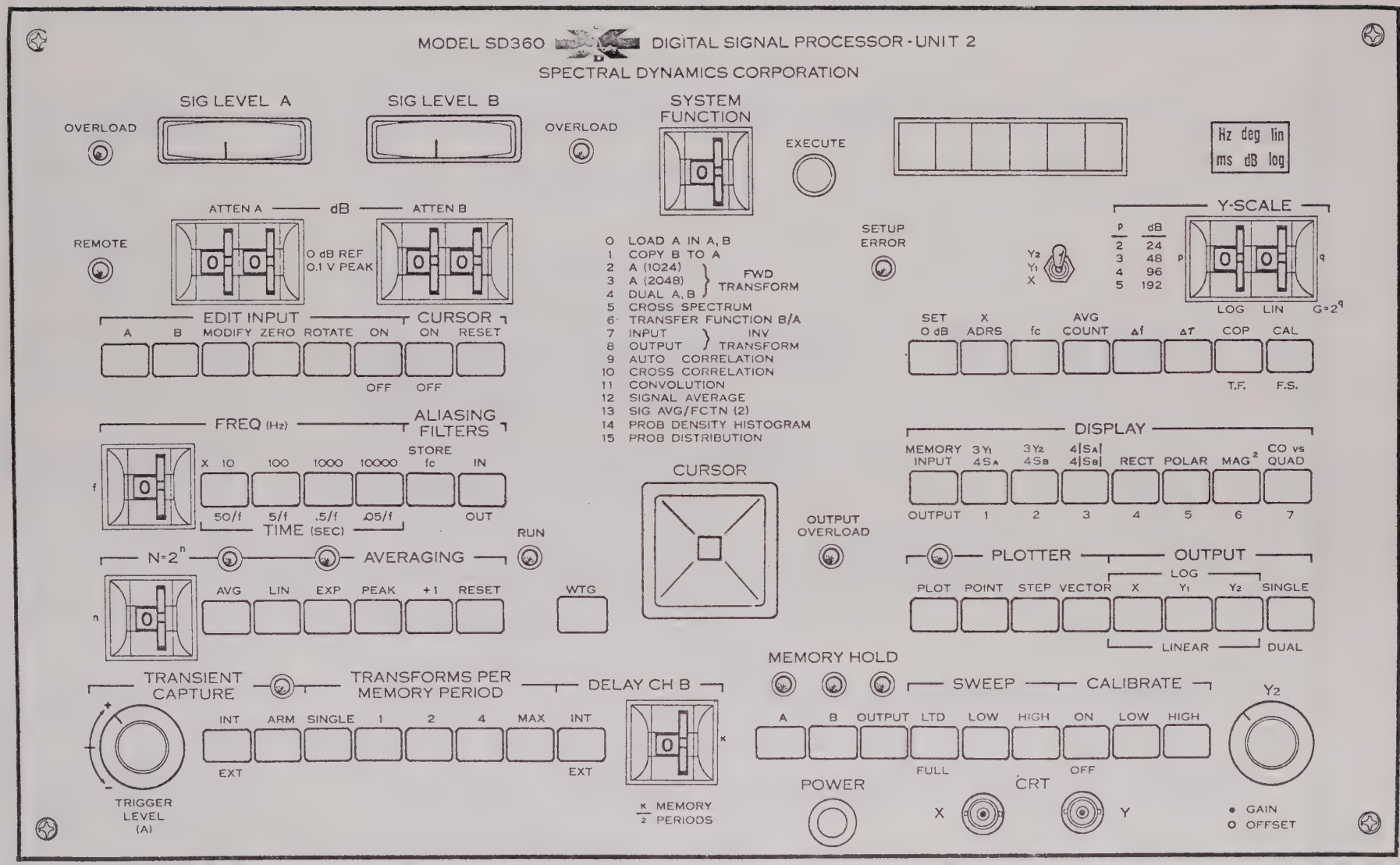


Figure A-1. DSP Front Panel — Unit 2

A1.4 REAR PANEL CONNECTORS

CONTROL*	CONDITION	DESCRIPTION
		A1.4.1 Multipin Connectors, Unit 1
UNIT 1 CONTROL (50-pin Connector)		Interconnecting cable between Unit 1 and Unit 2. (See paragraph 2.3.1 for pin assignments.)
UNIT 1 DATA (50-pin Connector)		Interconnecting cable between Unit 1 and Unit 2. (See paragraph 2.3.1 for pin assignments.)
		A1.4.2 A IN/OUT Group, Unit 1
IN (BNC Connector)		Accepts channel A input data signal in parallel with the corresponding front-panel connector.
OUT (BNC Connector)		Output of signal conditioned channel A data.
		A1.4.3 B IN/OUT Group, Unit 1
IN (BNC Connector)		Accepts channel B input data signal in parallel with the corresponding front-panel connector.
OUT (BNC Connector)		Output of signal conditioned channel B data.
		A1.4.4 TRANS CAPTURE Connector, Unit 1
TRANS CAPTURE (BNC Connector)		Accepts an external signal for triggering transient capture.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
		A1.4.5 Power Input Group, Unit 1
F1 (Fuse Holder)		Accepts 3AG type SLO-BLOW fuse; 2.5A for 115 Vac or 1.5A for 230 Vac operation.
115/230 S1 (Switch)		Selects 115 Vac or 230 Vac operation.
POWER J8 (Receptacle)		Input for 3-conductor AC power cord, center terminal ground.
		A1.4.6 SCOPE Group, Unit 2
X (BNC Connector)		Provides X-axis output for oscilloscope display.
Y (BNC Connector)		Provides Y-axis output for oscilloscope display.
		A1.4.7 PLOTTER Group, Unit 2
X (BNC Connector)		Provides X-axis output for the X-Y plotter.
Y (BNC Connector)		Provides Y-axis output for the X-Y plotter.
		A1.4.8 SCOPE BLANKING Connector, Unit 2
SCOPE BLANKING (BNC Connector)		Provides output blanking pulses to the oscilloscope.

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
		A1.4.9 POINT SEEK Connector, Unit 2
POINT SEEK (BNC Connector)		Provides point seek pulses to the point plotter.
		A1.4.10 POINT COMPLETE Connector, Unit 2
POINT COMPLETE (BNC Connector)		Accepts point complete pulses from the point plotter.
		A1.4.11 PEN LIFT Connector, Unit 2
PEN LIFT (BNC Connector)		Provides contact closure to lower the pen on the X-Y plotter.
		A1.4.12 Multipin Connectors, Unit 2
AUX 1 (50-pin Connector)		Provides inputs and outputs for pulse and logic level control of a number of auxiliary operations. (See paragraph 2.3.12 for pin assignments.)
COMPUTER 2 (50-pin Connector)		Digital I/O to a minicomputer. (See paragraph 2.3.12 for pin assignments.)
COMPUTER 1 (50-pin Connector)		Remote sense of the front panel controls and remote control of the DSP. (See paragraph 2.3.12 for pin assignments.)
UNIT 1 DATA (50-pin Connector)		Interconnecting Cable between Unit 1 and Unit 2. (See paragraph 2.3.1 for pin assignments.)
UNIT 1 CONTROL (50-pin Connector)		Interconnecting Cable between Unit 1 and Unit 2. (See paragraph 2.3.1 for pin assignments.)

*All controls are pushbuttons unless otherwise indicated

CONTROL*	CONDITION	DESCRIPTION
		A1.4.13 Power Input Group, Unit 2
PWR J1 (Receptacle)		Input for 3-conductor AC power cord, center terminal ground.
115/230 S1 & S2 (Switches)		Select 115 Vac or 230 Vac operation.
F1 (Fuse Holder)		Accepts 3AG type SLO-BLO fuse; 10A for 115 Vac or 5A for 230 Vac operation.
F2 (Fuse Holder)		Accepts 3AG type SLO-BLO fuse, 5A.
F3 (Fuse Holder)		Accepts 3AG type SLO-BLO fuse, ½A.

*All controls are pushbuttons unless otherwise indicated

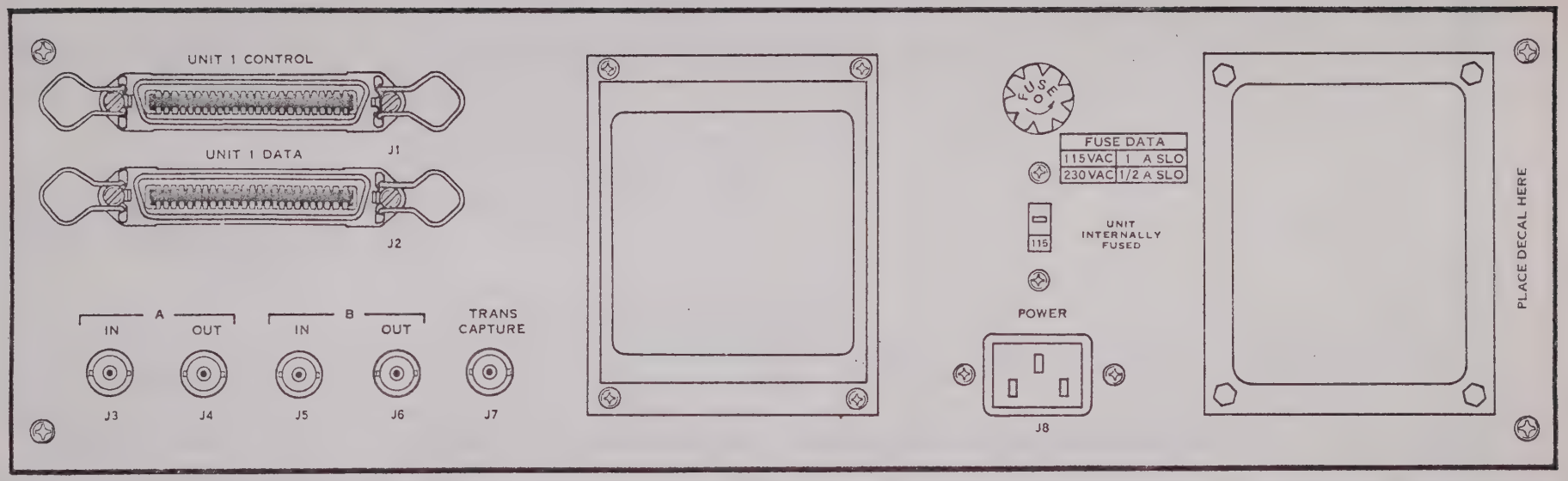


Figure A-2. Unit 1 Rear Panel

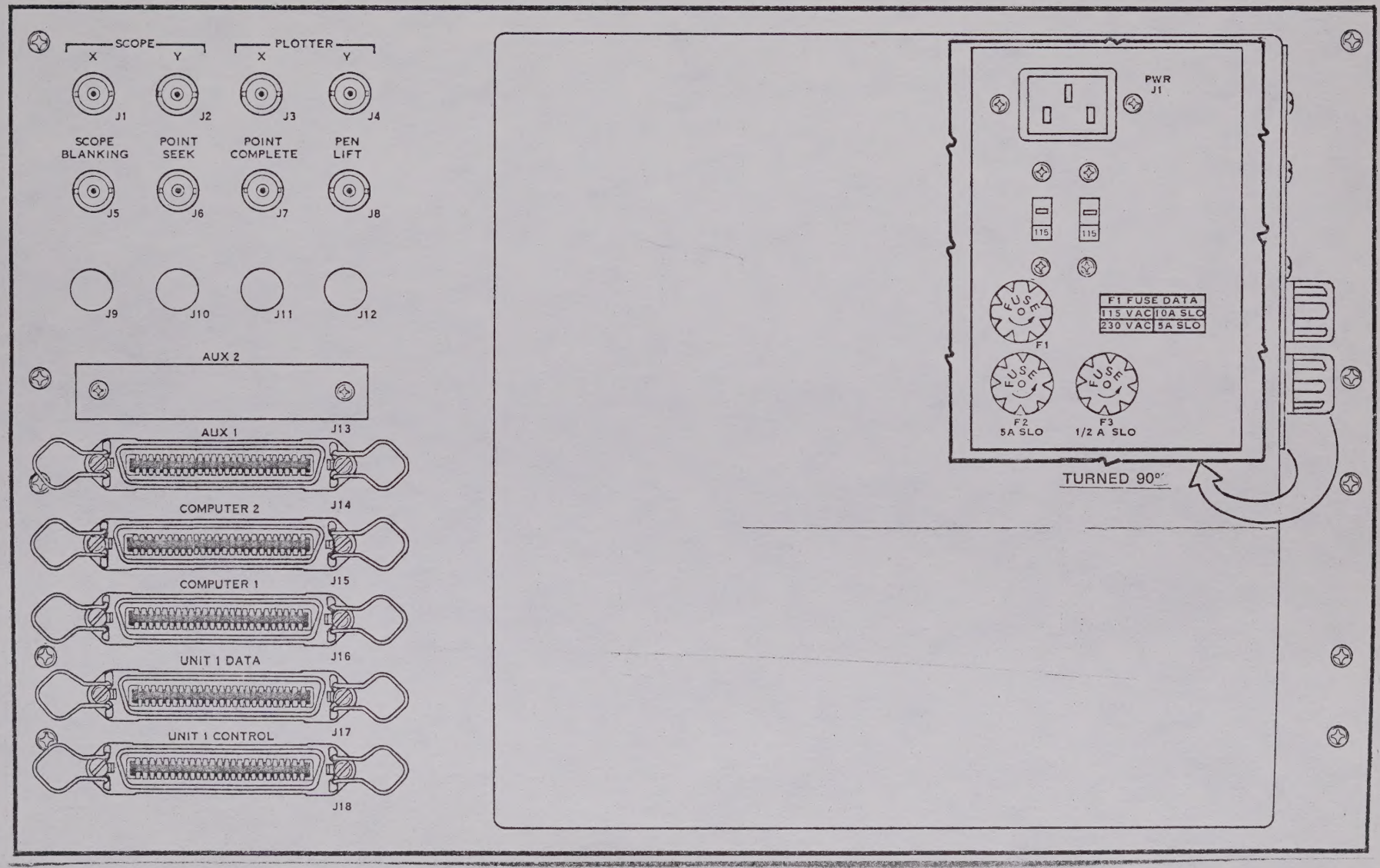


Figure A3. Unit 2 Rear Panel